Small Animal Dentistry

A manual of techniques

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This book is dedicated to my parents Leslie and Rena Tam who did not spare anything in allowing us to develop into the people we are today, and to my wife Kim whose love I cherish.

In reviewing dental embryology and development I have once again come to realize the intricate way in which our bodies have been constructed and reaffirm that there is a God who commands our belief in Him.

Contents

Acknowledgements

I was introduced to veterinary dentistry as an undergraduate student by Dr Frank Verstraete and was subsequently able to pursue this interest during a seven year sojourn in the United Kingdom. During this time Dr Cedric Gorrel and Judith Simpson were instrumental in broadening my 'dentistry horizons' and they were a pleasure to work with. Veterinary dentistry is not a procedure that can be performed in isolation by the veterinary surgeon and I have had the privilege of working with a number of competent veterinary nurses. Ruby Young and Sue Vranch were extremely helpful to me especially during the early years when some procedures took longer than they do now! Numerous members of the British Veterinary Dental Association and the European Veterinary Dental Society and College have encouraged me through the years and their help has been appreciated. My rough sketches and descriptions have been converted into concise illustrations by Dr David Crossley, whose help is acknowledged.

I would like to thank Antonia Seymour for initiating this project and for her patience with its often delayed progress.

Kim, my wife, has helped me tirelessly. Her attention to detail kept me from being verbose and thanks to her your navigation through this book using the index will be a pleasure.

To the editorial and composition/typesetting staff at Blackwell Publishing and their copy editor my sincere thanks for your help, encouragement and keeping the project on track!

1 Tooth Development (Odontogenesis)

Dogs and cats have two sets of teeth, namely the primary or deciduous dentition, and the secondary or permanent dentition. The primary dentition develops during the embryonic and foetal stages, while the permanent dentition develops during the foetal and neonatal stages of development. Tooth development progresses through a number of stages.

Stages of tooth development

Initiation stage

Induction (an interaction between odontogenic tissues) is necessary for initiation to begin. The influence of mesenchymal tissue on ectodermal tissue is known as odontogenesis.

The primitive oral cavity is lined by ectoderm, the outer portion of which gives rise to the oral epithelium and is separated from the underlying mesenchyme (influenced by neural crest cells) by the basement membrane. The oral epithelium grows down into the mesenchyme giving rise to the dental lamina.

Bud stage

The dental lamina proliferates into the mesenchyme forming buds from which the teeth will develop. The mesenchyme also proliferates, still separated from the dental lamina by the basement membrane. All teeth develop from ectoderm and mesoderm which is influenced by neural crest cells.

Cap stage

Proliferation continues with differential growth of parts of the tooth bud leading to a cap shape. The predominant process during this stage is morphogenesis which determines the eventual shape of the tooth. Deep within the tooth bud the enamel organ develops, the inner layer of which will determine the crown shape. The enamel organ, which is of ectodermal origin, will produce enamel to cover the surface of the tooth crown. Within the confines of the cap the mesenchymal tissue forms the dental papilla from which the dentine and pulp will develop. The dental papilla remains separated from the enamel organ by the basement membrane. The dentinoenamel junction (DEJ) will develop as part of the basement membrane which it encapsulates. The fibroblastic tissue surrounding the enamel organ forms the dental sac from which the periodontium will develop. The periodontium is thus of mesenchymal origin.

The three structures present at the end of the cap stage, namely the enamel organ, dental papilla and the dental sac, are collectively known as the tooth germ.

Bell stage

Proliferation, morphogenesis and differentiation continue. The cells of the enamel organ differentiate into four distinct layers:

(1) inner enamel (dental) epithelium which will differentiate into ameloblasts and produce enamel;

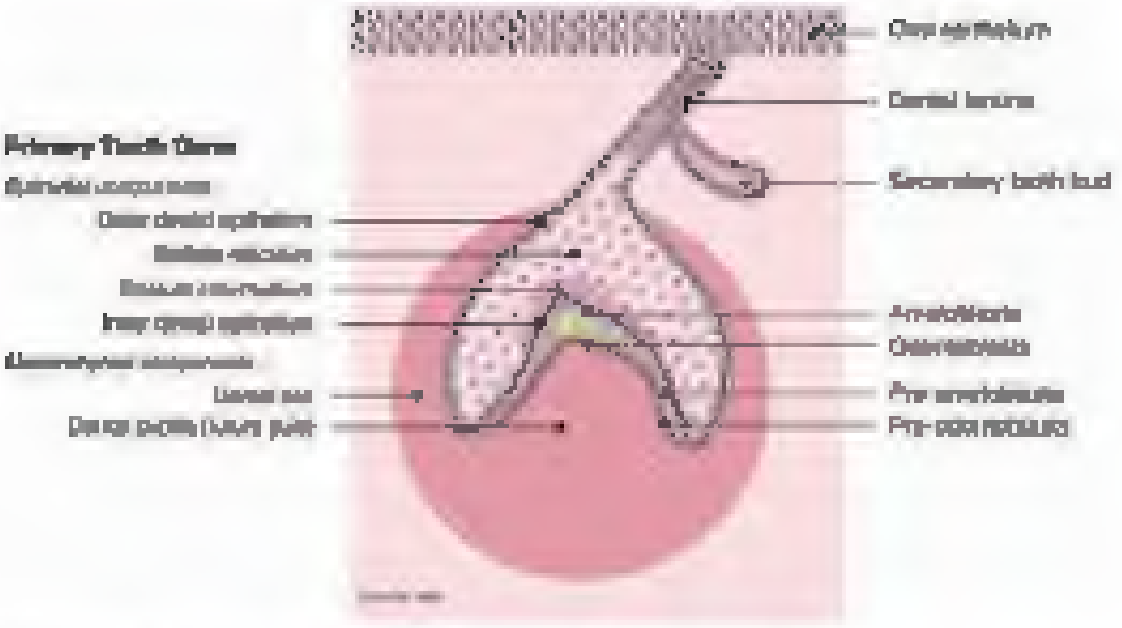


Figure 1.1 The tooth germ consists of the enamel organ, dental papilla and dental sac.

(2) stratum intermedium supporting enamel production

(3) stellate reticulum supporting enamel production

(4) outer enamel (dental) epithelium which protects the enamel organ during amelogenesis (Figure 1.1)

The enamel organ is still separated from the dental papilla by the basement membrane.

Concurrently the dental papilla differentiates into two layers: the outermost layer will differentiate into odontoblasts and produce dentine while the inner layer will develop into the tooth pulp. The dental sac will differentiate into its separate tissue layers, alveolus, periodontal ligament and cementum, at a later stage.

Apposition and maturation

During apposition, the matrices of enamel, dentine and cementum are laid down which will be mineralised into the final structures during maturation.

The developmental process

During the bell stage the inner enamel epithelium differentiates into pre-ameloblasts which induce the outer cells of the dental papilla to differentiate into odontoblasts which secrete pre-dentine on their side of the basement membrane. At this stage the basement membrane separating the pre-ameloblasts and odontoblasts disintegrates. Contact with pre-dentine induces the pre-ameloblasts to develop into ameloblasts which begin amelogenesis, secreting enamel matrix via Tome's process, and the disintegrating basement membrane. The DEJ is formed by mineralisation of the disintegrated

basement membrane. Secretion of both dental matrix enzymes by the cells (odontoblast and ameloblast) occur from the DEJ. The ameloblasts lose contact with the DEJ, but the odontoblasts retain contact via the odontoblastic process within the dentinal tubule. Odontoblasts remain vital within the pulp but ameloblasts are lost after tooth eruption.

Primary dentine is produced until apexogenesis (development of the tooth root apex) is complete. Secondary dentine is laid down from completion of apexogenesis throughout the life of the tooth. Under certain circumstances when the tooth is damaged, the pulp will be stimulated to produce tertiary or reparative dentine in an attempt to protect the pulp from exposure. Tertiary dentine is less structured than secondary dentine and becomes stained leading to brown or brown spots usually in the centre of worn tooth surfaces. These discoloured spots must be differentiated from exposed, carious pulp chambers and canal orifices.

The dentinal tubules are usually patent from the pulp to the dentine-enamel junction (DEJ) and dentine-cemental junctions and hence the odontoblastic processes and sensory nerves. Exposed dentine can therefore cause severe pain and must be treated.

Root development

Once the crown is fully formed and begins to erupt into the mouth root development begins. The root is formed by the cervical loop which is the most apical portion of the original enamel organ and is composed of the two epithelial layers (inner and outer enamel epithelium). The cervical loop grows down into the dental ectomesenchyme of the dental papilla forming Hertwig's root sheath. Hertwig's root sheath determines the shape of the tooth and induces production of root dentine. Root and crown dentine are continuous and separate structures.

The inner enamel epithelial cell layer of Hertwig's root sheath induces the outer cells of the dental papilla to become odontoblasts which produce predentine in a similar manner to that formed in the crown. After formation of root dentine, the basement membrane which has until now separated Hertwig's root sheath from the dental papilla, disintegrates along with Hertwig's root sheath. The remnants of Hertwig's root sheath are called the epithelial rests of Malassez which are located in the mature periodontal ligament (Figure 1.2). When stimulated, these cells may develop into cysts and require treatment. The root continues to develop until the apex is formed. The apical delta has numerous ramifications through which the pulp communicates with the periodontal ligament. Trauma to the immature tooth may cause pulpitis followed by pulp necrosis which will interfere with apexogenesis and may result in tooth death, requiring extraction. Damage to the developing root may cause an angulation of the root known as dilaceration.

Cementum

Undifferentiated cells of the dental sac are exposed to the root dentine when Hertwig's root sheath and the basement membrane disintegrate, inducing them to become cementoblasts. Cementoblasts secrete cementoid which becomes cementocytes (cementoblasts which become trapped in the cementoid).

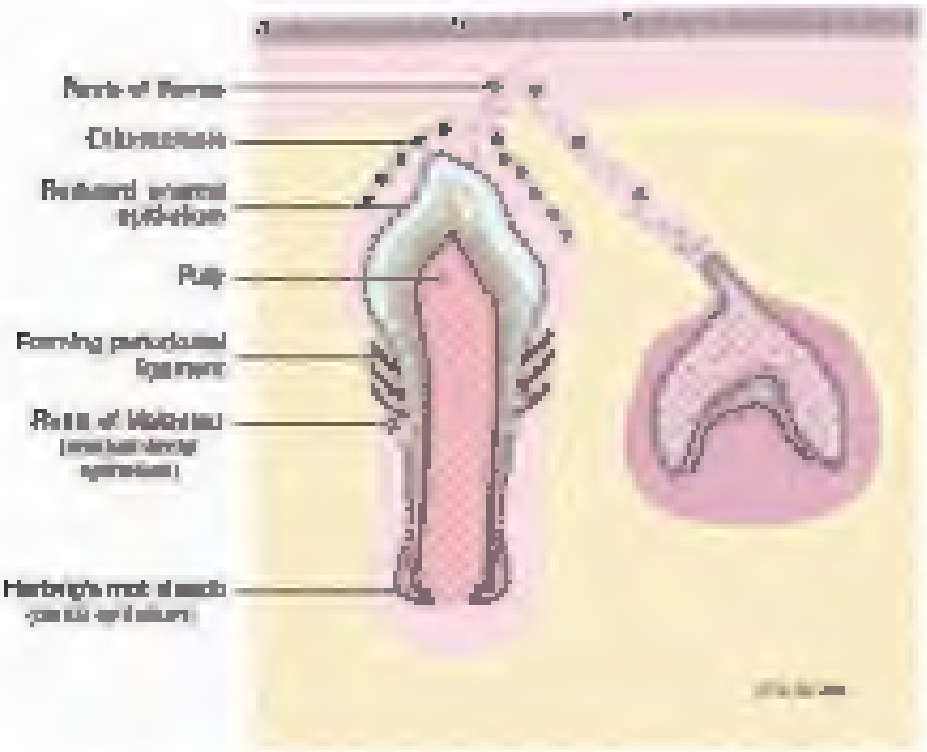


Figure 1.3 [illegible] when the teeth erupt into the mouth.

Cementoid undergoes mineralisation into cementum. Apposition of cementum on root dentine forms the dentine-cemental junction.

In man the cemento-enamel junction presents in one of three arrangements:

(1) in 60% of teeth cementum overlaps enamel

(2) in 30% cementum just reaches abut

(3) in 10% there is a gap between cementum and enamel.

In (3), exposed dentine leads to dentinal hypersensitivity which is painful. This can occur in some animals as well. Where dentine is exposed it should be sealed with an unfilled resin, varnish or sealant.

Hypercementosis is the production of excessive cementum on the apical third of the root. This can occur as a result of chronic inflammation and may complicate extractions in man (Figure 1.3).

Periodontal ligament

The periodontal ligament withstands rotational and other forces applied to the teeth keeping it within the alveolus.

During crown and root development, mesenchyme from the surrounding dental sac begins to form the periodontal ligament and the tooth alveolus. Collagen fibres are formed which span the space between the cementum and the alveolar bone supporting the tooth within the alveolus. The periodontal ligament is made up of a number of fibre groups:

Figure 9.3 Dog with a badly right premolar affected by hypercementosis. Note the lack of periodontal ligament space.

- the alveolar crest group, which span the alveolar margin and the cervical part of the root and which resist extrusion, intrusion and tipping forces
- the horizontal group of fibres which span the cervical part of the root and the alveolar wall which resist tooth mobility primarily resisting tipping and rotational forces.
- the oblique group of fibres which extend margino-apically from the alveolar wall to the root surface, preventing intrusion of the tooth and resisting tipping forces
- the apical group which span apicomarginally from the alveolar wall to the root, preventing extrusion of the root and resisting rotational forces.

In maintenance teeth with periodontal disease there may be loss of these periodontal fibres and periodontal pockets (Figure 9.4).

What happens when things go wrong during tooth development?

Initiation stage

Anodontia (absence of teeth) or partial anodontia (hypodontia) results from failure of initiation. Supernumerary teeth are caused during initiation and may cause crowding (Figure 9.5). When crowding occurs, supernumerary or abnormal teeth should be removed or corrected (Figure 9.6). Some breeds have developmental anomalies which could be characterised with dysplasia. Most Chinese crested dogs have anomalous missing teeth. This is an inherited condition rather than an interceptable lack of stimulus (Figure 9.7).

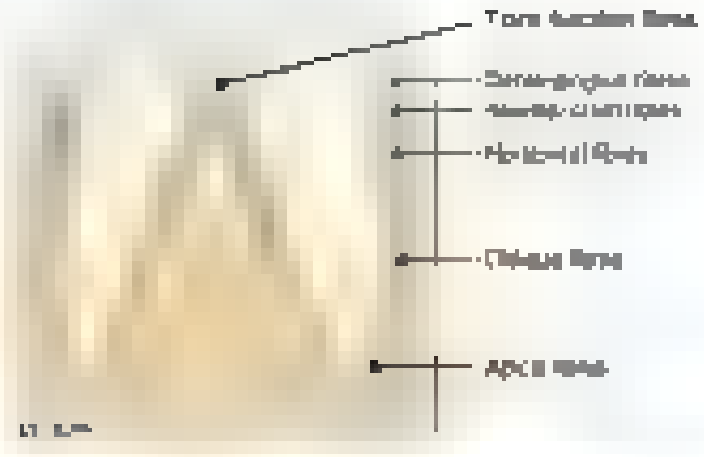


Figure 4 The mandibular alveolar process in the dentate and edentulous patient. Note the loss of bone in the edentulous patient.

Figure 5 Mandibular alveolar ridge preservation (MARP) technique. The root can be seen in this mandibular incisor socket with minimal remodeling.

Bud stage

Mesenchyme condenses to form a bud-shaped epithelial enamel organ.

Cap stage

Deepening of the bud. The enamel organ invaginates into the bud, creating a cup-like structure. The dental papilla and dental sac begin to develop.

Figure 1.3 Supernumerary mandibular left 4th premolar (arrow) and the supernumerary tooth has caused periodontal disease affecting the surrounding teeth necessitating extraction

Figure 1.4 Hyperdontia (arrow) and malocclusion in a Cavalier crossbred dog

may be minor displacement or rotation due to malocclusion as radiographed in extraction domains

connection in the complete or partial split in a single tooth but numerous in a mirror-image crown. Crowns where are more images of these other figure 1.4 The given the impression of an incisor tooth in the affected

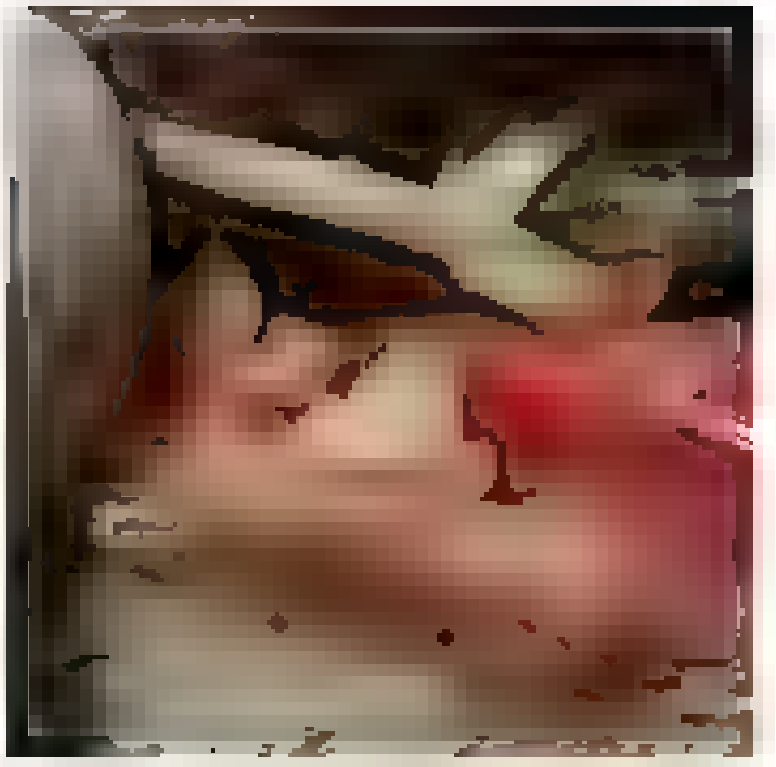


Figure 4 Cone-beam computed tomography (CBCT) image of a patient in right lateral position showing the left maxillary sinus with mucosal thickening and air-fluid level. The patient was scanned with head in a head holder.

Figure 5 Cone-beam computed tomography (CBCT) image of a patient in right lateral position showing mucosal thickening and air-fluid level in the maxillary right quadrant.

quadrant and a mucosal thickening is seen along the floor (Figure 4). The lesion was also partially visualized in the upper (Figure 5).

Based on the CBCT findings, a provisional diagnosis of maxillary sinusitis with odontogenic origin was made. The affected quadrant was then treated (Figure 6).

A provisional surgical treatment plan was formulated and the patient was

Figure 1.18 Stereograph of a male
Figure [illegible] shows significant [illegible]
accumulation of the residue in the dentoid
notch

Figure [illegible] Dental examination with
mirrors and [illegible] showing a large
tooth and [illegible] in the
maxillary left arcade

Appositional and interstitial

Enamel dysplasia Enamel hypoplasia is a reduction in the quantity of enamel produced, leading to pitting and grooves on the tooth, which makes hypomineralization [illegible] to reduce [illegible] staining. Discolored teeth

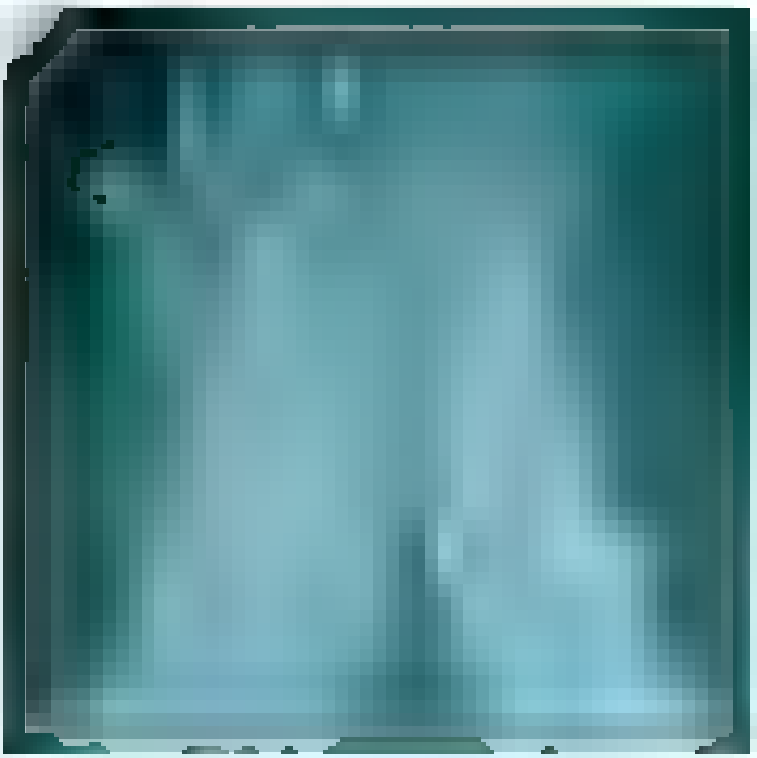
Chronic dysplasia may also occur. These conditions are often seen in dogs which have suffered acute Distemper Virus infection and those which have sustained bouts of pyrexia during tooth-germ and dentinogenesis (Figures 1.12–14). The Distemper virus can damage tooth-enamel and

Figure 1.16 Enamel hypoplasia and dysplasia in a dog suffering from distemper virus infection. Note the severe periodontal disease affecting some incisors. There is a build-up of plaque accumulation on these teeth

Figure 1.17 Enamel hypoplasia and dysplasia in a dog suffering from [illegible] [illegible]. Note the [illegible] mandibular left [illegible] [illegible]

ameloblasts and often results in abnormally shaped crowns which undergo premature [illegible] of [illegible] (Figures 1.16, 1.17).

Iatrogenic damage to the [illegible] before [illegible] months of age can present as [illegible] enamel defects in the permanent dentition [illegible]



[illegible] occurred during the eruption of deciduous teeth (Figure [illegible]). Fractured deciduous incisor with exposed pulp leading to periapical pathology can also cause enamel defects on the developing permanent tooth (Figure [illegible]).

Figure [illegible] Radiograph showing [illegible] with [illegible] and [illegible] from [illegible] infection. Note the [illegible] Premature completion of [illegible] has occurred.

Figure [illegible] Radiograph of the [illegible] mandibular [illegible] showing from [illegible] infection. Note that the permanent [illegible] are [illegible] uncoupled due to premature [illegible] of [illegible]. [illegible] tooth may [illegible] be extracted. Note also the [illegible] that [illegible].

Figure 1.18 Extreme care must be exercised when extracting permanent developing (germ) teeth, especially when their proximity to the primary predecessor and dental follicle may be the cause of damage to the tooth bud due to iatrogenic damage during extraction of the primary tooth. Note the degree of bone covering which this developing tooth has.

Figure 1.19 Fractured permanent incisor tooth with pulp exposure. Note the periapical pathology may result in damage to the underlying developing permanent tooth.

Tooth type and shape

Dogs and cats have three incisors and one canine on each quadrant. The incisors are named central, middle and lateral or numbered first, second and third.

Figure 2.8 The maxillary right deciduous canine is numbered 06 and the mandibular right deciduous canine is numbered 07 using the modified Zsigmondy system.

Using the modified Zsigmondy system, the quadrants are numbered from 1 to 4, beginning with the right maxilla and moving with the right mandibular to the left mandibular. Numbers from the front of the mouth to the back of the mouth are assigned to the maxillary right quadrant (1) numbers 01 and 02, canine (3) numbers 03, premolars (4) numbers 04 and 05, and molars (5) numbers 06, 07, and 08. The primary dentition (numbers 01 to 05) uses only the quadrants of the maxillary right (5) and mandibular right (8) quadrants (5) and (8). The maxillary right quadrant (5) includes numbers 01 to 05, and the mandibular right quadrant (8) includes numbers 01 to 05. Figure 2.8 shows the modified Zsigmondy system showing the deciduous teeth numbering system. Note the thin dental space that appears between the primary incisors.

In dogs with a full complement of permanent teeth, the dental formula is

$$2 \times \frac{\text{I } 3/3 \quad \text{C } 1/1 \quad \text{P } 4/4 \quad \text{M } 2/3}{\text{I } 3/3 \quad \text{C } 1/1 \quad \text{P } 4/4 \quad \text{M } 3/3} \quad \text{giving a total of 42 adult teeth}$$

Dogs do not have any premolars or molars in the deciduous dentition.

$$2 \times \frac{\text{di } 3/3 \quad \text{dc } 1/1 \quad \text{dp } 3/3}{\text{di } 3/3 \quad \text{dc } 1/1 \quad \text{dp } 3/3} \quad \text{giving a total of 28 deciduous teeth}$$

Figure 2.9 shows the mandibular right deciduous incisors, canine, and premolars (3) as a young dog. Figure 2.10 shows the permanent mandibular right incisors, canine, and premolars as well as the deciduous canine and premolars as a young dog. The dominant permanent incisors, canine, premolars, and permanent molars are present.

In cats with a full complement of permanent teeth, the dental formula is

$$2 \times \frac{\text{I } 3/3 \quad \text{C } 1/1 \quad \text{P } 3/2 \quad \text{M } 1/1}{\text{I } 3/3 \quad \text{C } 1/1 \quad \text{P } 3/2 \quad \text{M } 1/1} \quad \text{giving a total of 30 adult teeth}$$

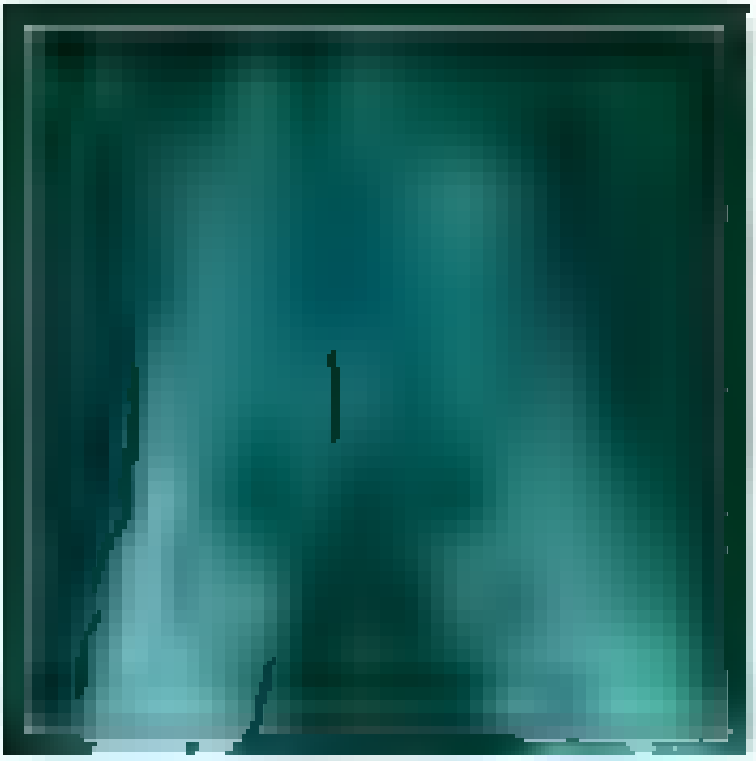


Figure 1.21 Radiograph (ventral mandibular) of a young dog with developing permanent teeth.

Figure 1.22 Radiograph (ventral mandibular) of a young dog that has hypoplastic mandibular discoloration. Note how crowded the permanent incisors are and how close the permanent canines are to each other.

Figure 1.35 [illegible]

Figure 1.36 [illegible]

[illegible]

$$\times \frac{\text{[illegible]}}{\text{[illegible]}} \text{ giving a total of [illegible]}$$

Figure [illegible] shows the mandibular right dentulous teeth in a lateral. The [illegible] and [illegible] are [illegible] and [illegible]. Figure [illegible] shows the mandibular right premolars in lateral view and [illegible] and premolars [illegible] and [illegible] and molars [illegible].

Dentulous [illegible] without the mandibular first premolar and removed molars. [illegible] mandibular premolars [illegible] and [illegible] and molars [illegible].

[illegible] depth [illegible], [illegible], [illegible], premolars and mandibular third molars have [illegible] which [illegible] remaining mandibular premolars and molars

Figure 2.3 Mandibular right alveolar bone in dog. Note the root concavities more than 50% of the teeth and mesial to greater diameter of alveolus between roots of the root

Figure 2.4 Upper maxillary molar area. Note the root canal and palatal root of the first molar. Buccal root of third molar. Note the root of the maxillary molar

have two roots. Mandibular premolars 2 and 3 have two roots while mandibular premolar 4 and all molars have three roots (Figure 2.3 and 2.4).

Root configurations are similar to the exception that the maxillary molar buccal roots can be fused.

Some pre-molars which may have a curve or which can cause root fracture should be taken into consideration before the need for pre-operative

Figure 1.29 An anteroposterior (AP) maxillary projection, or occipitomental (OM) projection, of the patient's skull. Tooth shadows are superimposed over the roots of the maxillary teeth.

Figure 1.30 Radiograph of tooth in Figure 1.29. Note the superimposition of the opposite maxillary molar (black arrowheads) over the distal root of the first molar. This could be mistaken for superimposition of the distal and mesial roots of the same tooth.

radiographs (Figures 1.29 and 1.30). To be certain that maxillary second premolar actually has a distal root, the patient must have two periapical radiographs taken at different horizontal angulations. The first radiograph is usually taken using the paralleling technique, and the second is usually taken using the bisecting-the-angle technique. Two periapical radiographs, one horizontally angled mesially and the other horizontally angled distally, are necessary to ensure that the roots of the premolar are not superimposed over each other (Figure 1.31).

Figure [illegible] [illegible] root(s) in a dog mandibular premolar. Pre-operative radiography is necessary to prevent attempts at removing [illegible] for extraction [illegible] teeth [illegible] be extracted using the simple extraction technique.

Figure [illegible] [illegible] placed in the distal root of maxillary left premolar ([illegible]) in a cat.

Figure [illegible] shows a [illegible] with the distal root of [illegible] maxillary left premolar [illegible] in a cat. Figure [illegible] shows the tooth in Figure [illegible] after sectioning and extraction.

In the dog, the maxillary molars [illegible] and [illegible] and the mandibular molar [illegible] have a cutting and a grinding surface, while mandibular molars 2 and [illegible] have a single

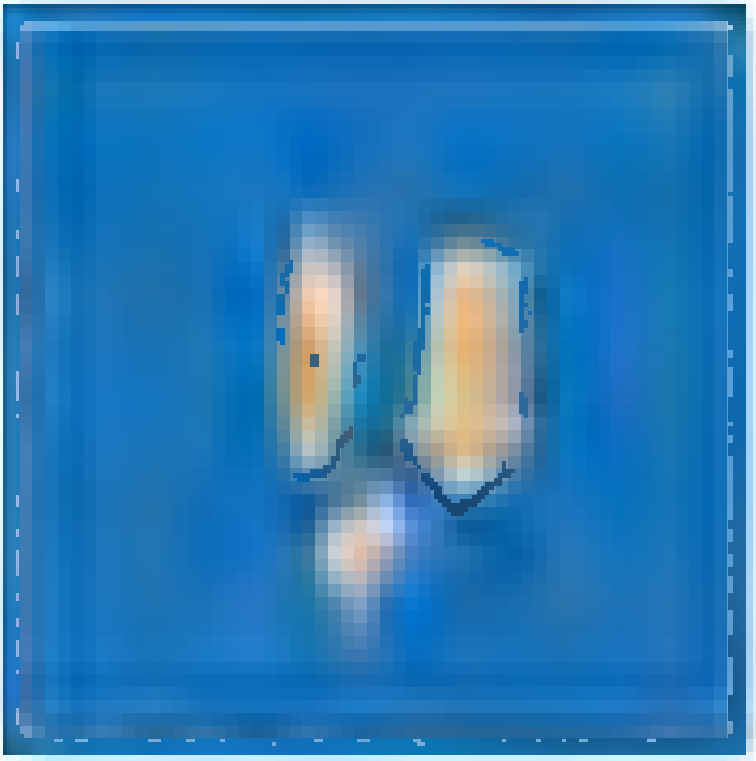


Figure 1.33 The estimated tooth bone, the pulp region, the gingival margin, enamel, and dentine have been removed to improve visibility of the pericervical gingival space.

grinding surface (for molar teeth bring functional cusp tooth with a grinding surface). Except for the mandibular first molar, the deciduous teeth have grinding surfaces with a pair of functional cusp teeth. Teeth without grinding surfaces are termed accessory.

In the dog the premolars and molars with the exception of the first premolars (in other words they are not true monophyodont teeth).

Permanent incisors erupt palatal to their deciduous incisors while the maxillary permanent canines erupt labial to the deciduous canines and the mandibular permanent canines erupt to the deciduous canines. Permanent premolars erupt palatal to their predecessors. Permanent maxillary deciduous molars (Figure 1.34) and permanent mandibular deciduous canines (Figure 1.35) are monophyodont in dogs but appear to be premolars (see Figures 1.34 and 1.35).

Permanent teeth erupt as shown in Table 1.

Tooth (permanent dentition)	Approximate age (in months)	
	Dogs	Cats
Incisors	4 months	4 months
Canines	4 months	6 months
Premolars	4–6 months	4–6 months
Molars	4–5 months	4–5 months

Table 1 Age at which permanent teeth erupt in dogs and cats

Figure 2.8 Maxillary right permanent deciduous canine tooth (deciduous eye or upper eyetooth) caused by plaque and food trapping

Figure 2.9 Mandibular permanent deciduous incisor teeth (baby teeth) caused by

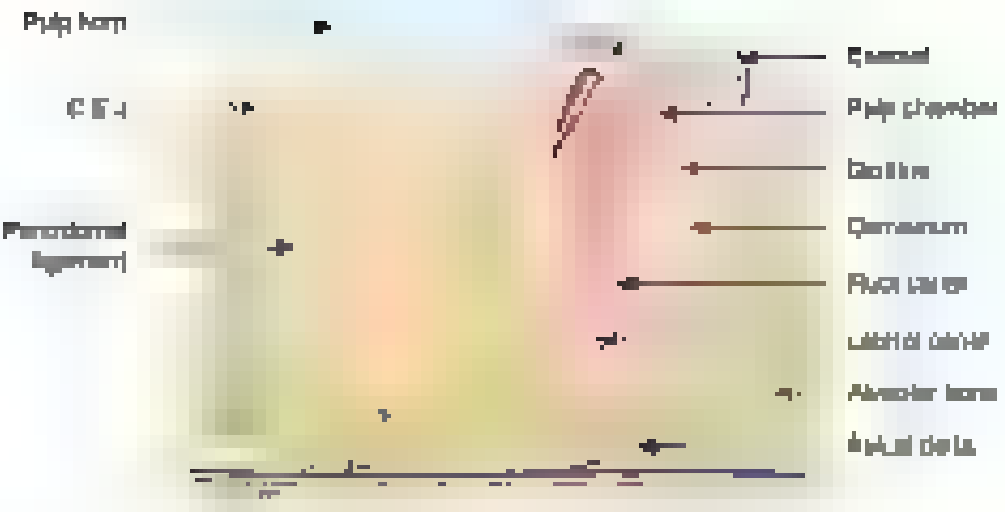
Tooth anatomy and directional terms

The crown of the tooth is the part of the tooth that is in the mouth and covered by enamel. The crown joins the root at the tooth neck. The cementoenamel junction (CEJ) separates the crown from the root which is covered by

Figure [illegible] Maxillary left permanent dentition: lateral [illegible] and premolars 4 [illegible] in a young adult

Figure [illegible] Maxillary right permanent dentition: lateral incisor, canine, first and second premolars 4 [illegible] in a young adult. Same individual as in Figure [illegible].

[illegible] Figure [illegible] and [illegible]. The crowns are divided into occlusal, mesial and gingival thirds, and the root into middle and apical thirds. The pulp chamber with crowns, roots, the coronal pulp and the root canals are shown as the coronal aspect of the teeth, while the pericervical area between the middle and



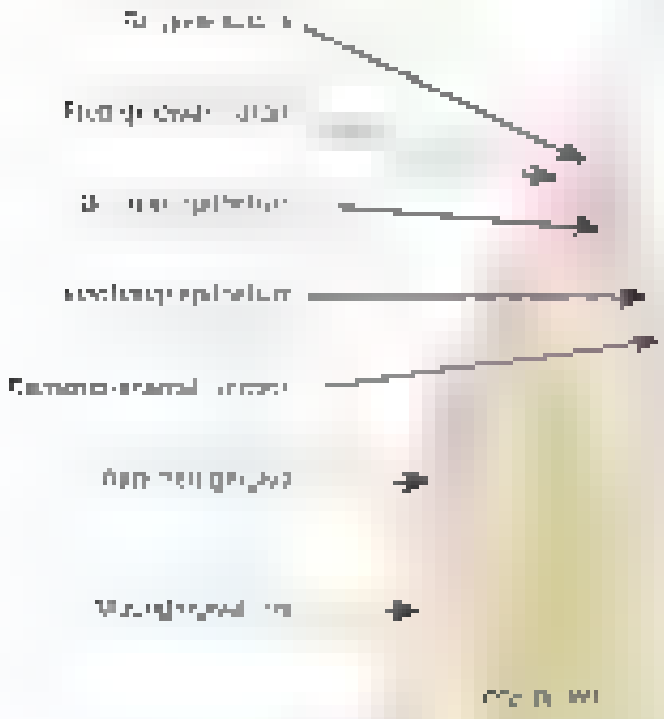
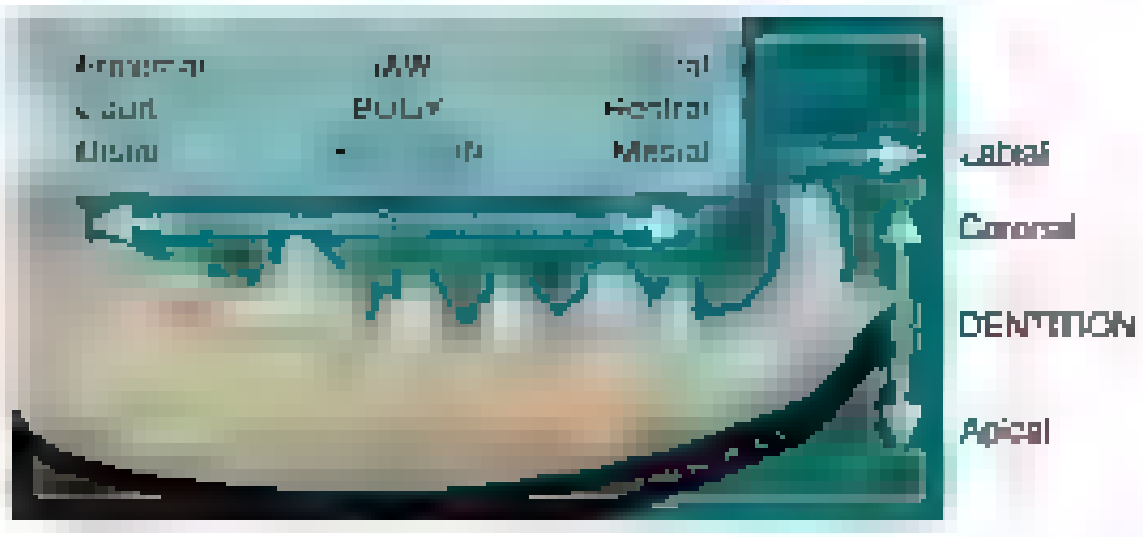
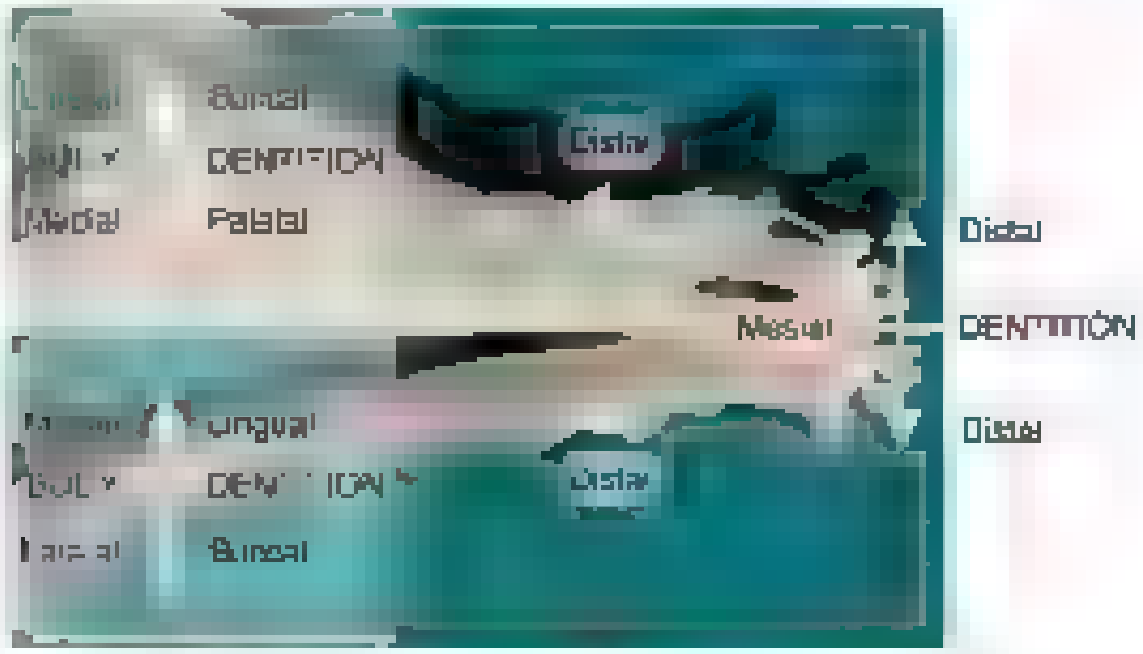


Figure [illegible] Schematic representation of [illegible] between teeth and alveolar bone





the distal aspect. Towards the coronal aspect the mesial surface is directed apically and towards the distal aspect. The distal surface is directed coronally (Figures 4d and 4e).

The 'base' of the mesial surface is directed coronally and the 'back' is directed apically.

The 'angle' is made up of the 'base' and 'back' and is described as the 'base' of the mesial surface.

The 'apex' is described as the 'back' of the mesial surface. Between the mesial surface and the distal surface is the 'interproximal space' which is the space between the adjacent teeth (Figures 4d and 4e).

The incisive papilla is situated just caudal to the mandibular canine tooth and marks the opening of the incisive-palatine canal (Figure 4-5).

The ducts of the mandibular and sublingual salivary glands are situated ventrally on either side of the lingual frenulum (Figure 4-5). The

Figure 4-4 Right lateral transluminal view of a young puppy

Figure 4-5 Right lateral transluminal view of a young adult dog. Note that the palatine papillae of the maxillary right canine tooth is not apparent due to the relatively small size of the mouth in this dog.

Figure 1.44 [illegible]
[illegible] and should not be mistaken for a tumour.

Figure 1.45 [illegible]
mandibular and sub-lingual salivary glands. An obstruction in the lingual [illegible] and retrieve [illegible] saliva production.

produced by the parotid and zygomatic salivary glands open always adjacent to the maxillary [illegible] (Figure 1.61). The buccal salivary glands produce secretions like the buccal mucosa (Figure [illegible]).

Tac this groove dividing the upper lip is lessened as the philtrum (Figure 4.8).

The lower row expresses two mandibles that embrace at the mento-labial symphysis (arrow).

Figure 1.48 The shallow groove separating the lip from the gum is known as the gingivosulcus.

Figure 1.49 The space between the teeth is known as a diastema. Note the diastema between maxillary right lateral incisor and canine and between canine and first premolar are visible.

The normal space between two teeth, for example between the maxillary lateral incisor and canine, is known as a diastema (Figures 1.49 and 1.50).

The line separating the alveolar mucosa and attached gingiva is known as the mucogingival line (Figure 1.

gingiva and moved from side to side, it will glide over the gingival surface. However, when a finger placed on the alveolar mucosa is moved from side to side the alveolar mucosa moves with the finger. The attached gingiva is fixed tightly to the underlying periosteum of bone and therefore does not move when the alveolar

Figure [illegible] [illegible] [illegible] [illegible] [illegible] and are often [illegible]

[illegible] a shallow [illegible] from the [illegible]

The palatine [illegible] [illegible] (Figure [illegible])

Further reading

[illegible]

Figure 2.1 The lips can be raised to obtain a good view of the teeth in most patients.

Figure 2.2 The axial cuts can be [illegible] [illegible]

[illegible] the head. Each [illegible] [illegible] Figure 2.3 axial and diagonal cuts can be [illegible] should [illegible] [illegible] [illegible]

Figure 8.3 The soft tissue visible
[illegible] gingival margin in the gloved
[illegible] of the left hand. The tissue
is enlarged and cauliflower-like, arising
from the [illegible] is highly suggestive of
histopathology and [illegible]
appearance [illegible] carcinoma.

Figure 8.4 Excessive gingival tissue
overgrowth in the mandible.

[illegible] wipes, dressings, [illegible] gauze swabs and commercially available pharmacological packs. The pack should be [illegible] the pharmacological [illegible]. Note that the function of these packs is to [illegible] protect surgical [illegible] and should not be [illegible] accompanying services. The [illegible] in the [illegible] and packs [illegible] preventing [illegible] of these materials during [illegible]

and recovery. The pack will not prevent fluid from accumulating around the tube.

When the patient can be mobilized under anesthesia the oral cannula can be withdrawn.

Figure 2.7 A pharyngeal pack should be placed around the tongue in the pharynx to ensure debris and blood flow down posteriorly during surgery to tube. Remember that the pharyngeal pack gets removed before the patient wakes up.

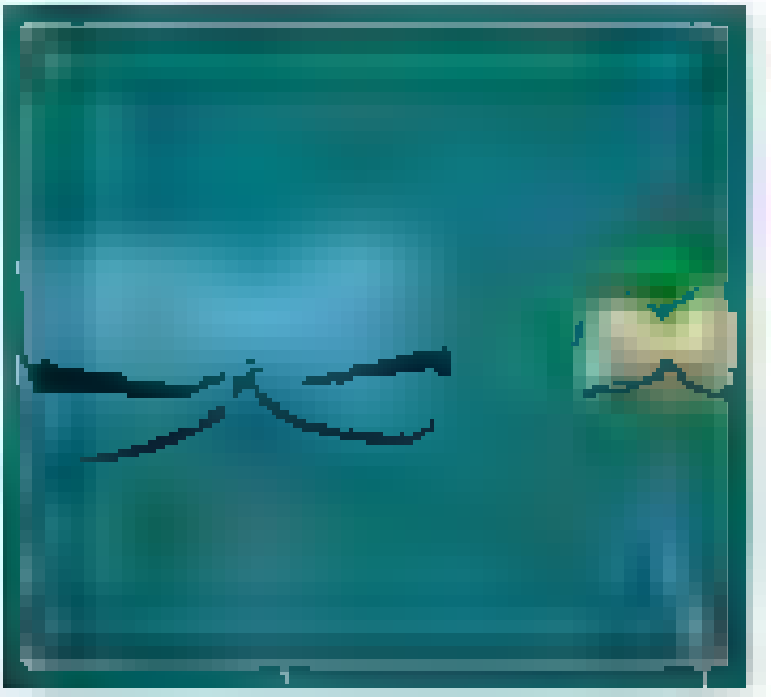


Figure 2.8 The pharyngeal packs in this photograph are cut from sterile kitchen sponges.

The clinician should be aware of the procedure and should develop a systematic approach to oral examination. An oral findings scoring sheet serves as an educational tool to record data on examination, planning a recording, and can be used for future reference or ongoing evaluations (Figure 2.9 and 2.10). A dental recording sheet is essential for recording clinical findings, treatment planning and treatment recordings. They also provide a comparison from examination to examination.

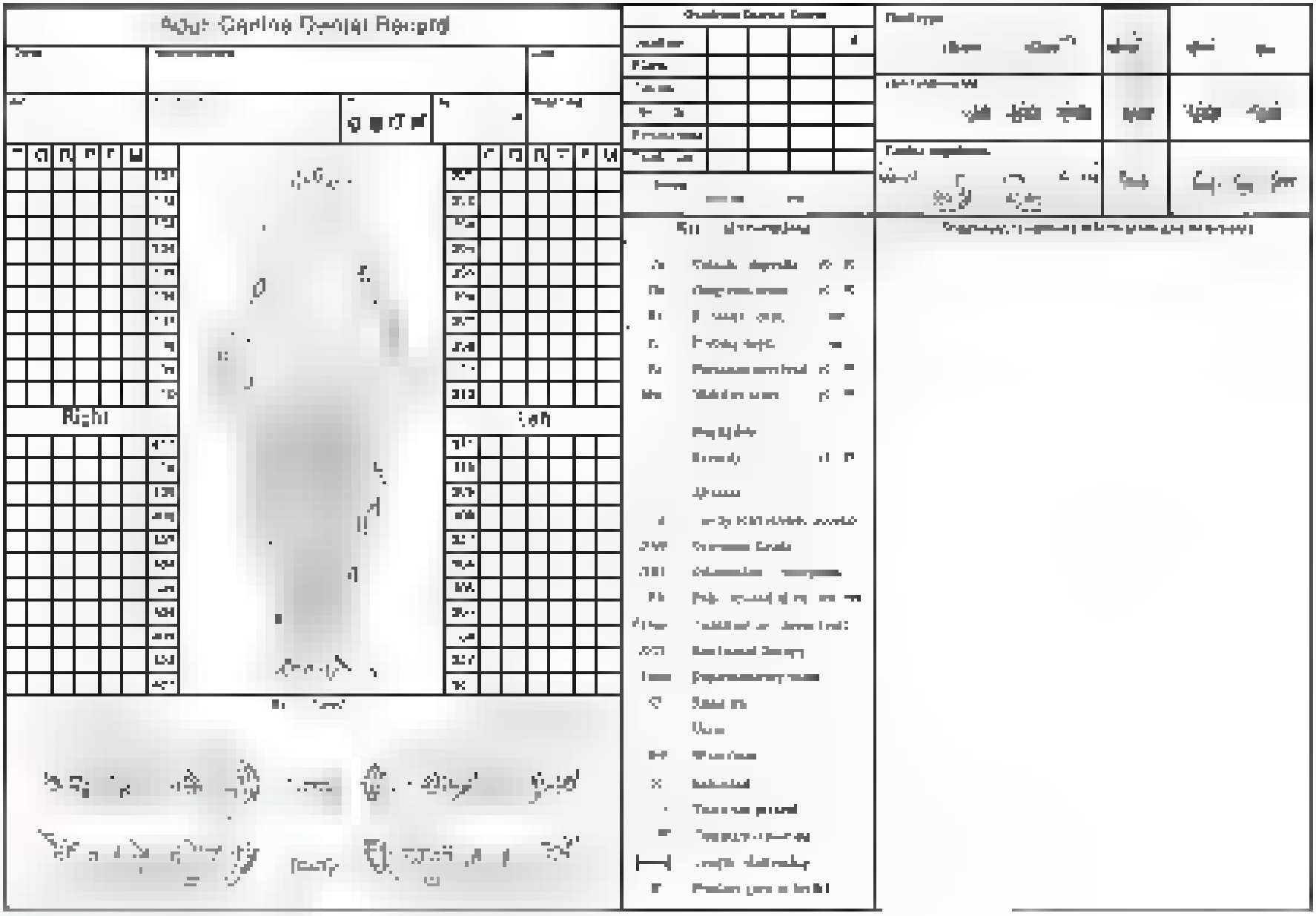


Figure 2.1a An example of a dental recording chart

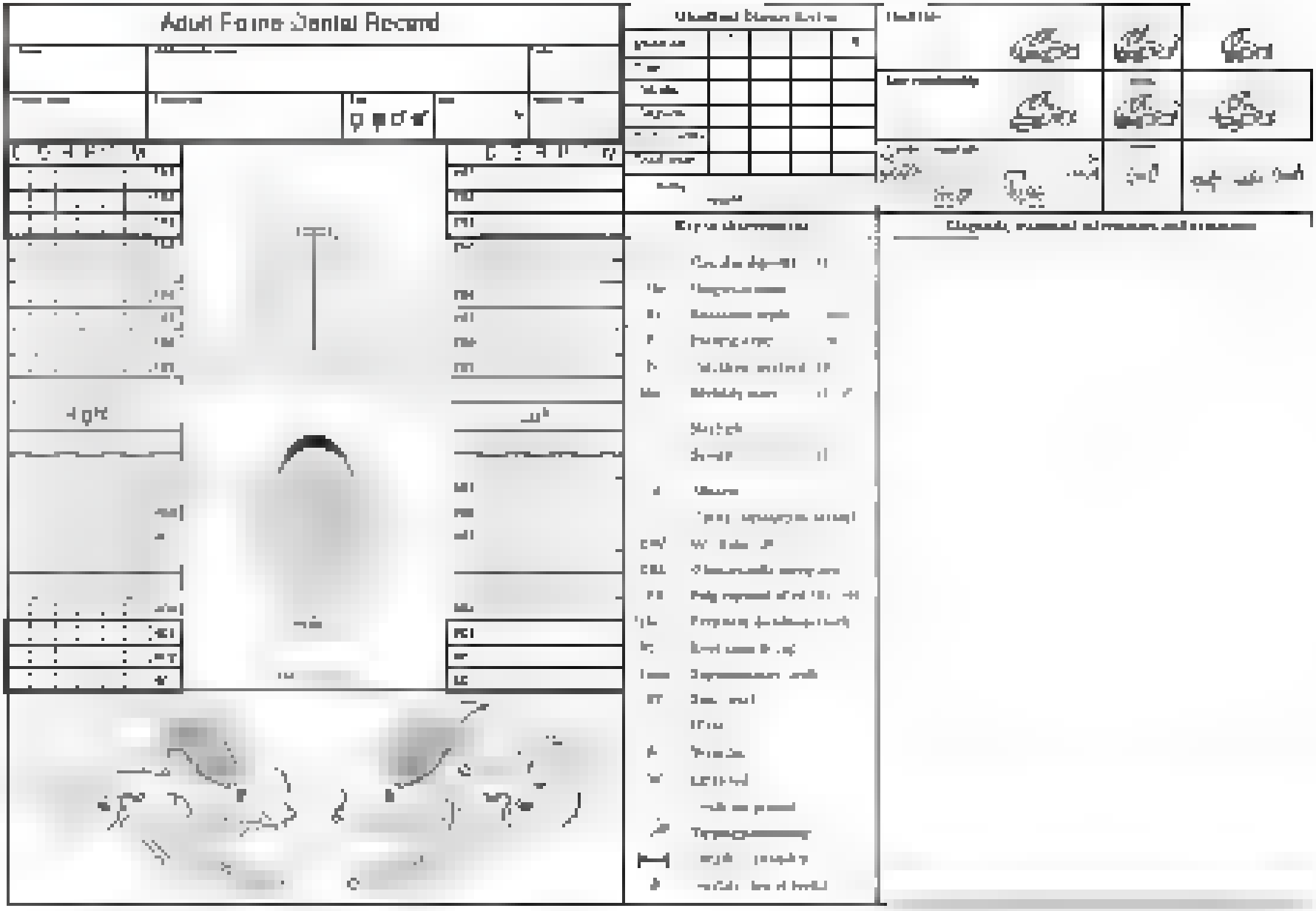


Figure 2.4 An example of a dental recording chart

Figure 2.18 Probing furcations

Each tooth should be examined individually along with its supporting structures. A periodontal probe (or explorer if calculus is present; see Chapter 3) is used to probe the tooth surface circumferentially. The tip of the probe is introduced into the sulcus and slowly carried around the tooth, assessing the depth of the sulcus (Figure 2.19). Most dental recording charts will make provision for recording sulcular or periodontal depths at several locations on each tooth. These should be at the mesial and distal buccal and oral lingual (palatal) aspects. Sulcus depths exceeding 3 mm (or bleeding on probing) are considered abnormal (Figure 2.20). Any other abnormalities, such as pathological pockets, furcation involvement, hypercementosis, gingival recession or an irregular margin (Figure 2.21), should also be recorded. The gingival recession can also be measured using a periodontal probe (Figure 2.22). The mobility of the tooth can be assessed by gently applying pressure (but not a lot) to the crown and observing any movement.

Figure 2.19 Presence of sub-gingival plaque can be demonstrated by probing the sulcus / pocket using a periodontal probe

Figure 2.20 Thin mucobuccal fold with hard, rigid and adherent

The periodontal probe can also be used to determine the thickness of plaque on the tooth surface and to measure the gingival sulcus / periodontal pocket. Figure 2.19 shows plaque in the mucobuccal fold plaque disclosing solution is required to reveal the presence (Figure 2.20).

Figure 2.28 Plaque disclosing solution has been applied to the teeth in Figure 2.27.

Figure 2.29 The teeth in Figure 2.28 after polishing. The polishing procedure will remove the remaining plaque, while gingival polishing is essential to remove the gingival plaque.

The progress index is recorded from [illegible] with 0 being healthy gingiva, 1 being slight inflammatory gingiva, characterized by swelling and marginal redness, 2 being moderate gingivitis characterized by bleeding on probing of the gingiva, and [illegible] being severe gingivitis characterized by spontaneous bleeding on being touched (Figures 2.27–2.29).

Figure 3.33 Stretching gingiva, removable plaque at the incisors

Figure 3.34 Slightly irregular, but otherwise healthy gingival margin, as evidenced by the deep hard and supragingival calculus (DHC, SGC)

Any excess *Extrude* should be further examined using the dental explorer. This fine instrument explores cervical contamination and will become entangled in excess *Extrude* and create a rug effect when removed from a tooth surface where it is explored.

Figure 1.25 Moderate gingivitis. Red
discoloration and bleeding on probing

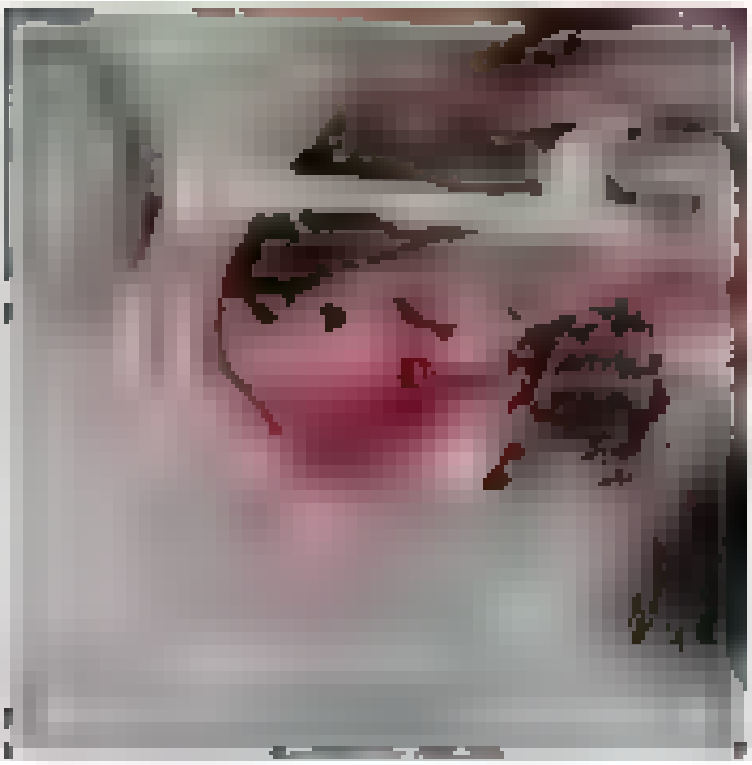


Figure 1.26 Severe gingivitis with
diffuse deep red discoloration

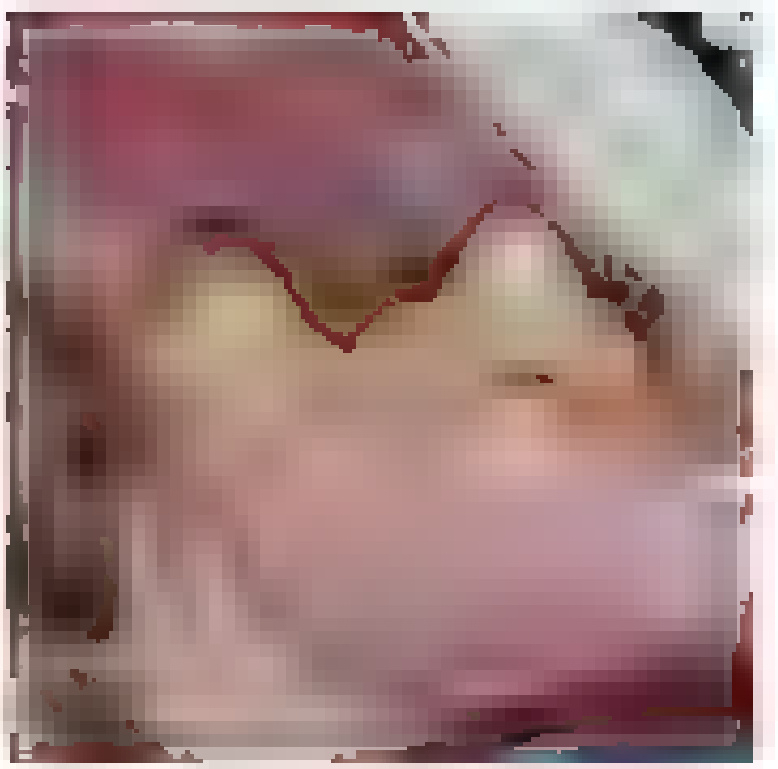
...alculus scores usually recorded as slight when there is a small amount of calculus at the gingival margin, moderate when there is more and supra-gingival calculus and heavy when the majority of the tooth surface is covered by calculus (Figure 2... 2...). Although calculus itself does not cause gingivitis it acts a

Figure 2.27 Healthy teeth and gums with no periodontal disease.

Figure 2.28 Slight periodontal disease

rough plaque retentive surface where bacteria penetrate disease. ✓
Table 2 ... abbreviations used in recording clinical findings

... the clinical examination is complete the oral cavity should be rinsed with 0.2% chlorhexidine gluconate oral antiseptic ... mouth product



Known to be effective against plaque-forming viruses, the neutralization of bacteriophage (Figure 2.15).

If the animal is suffering from severe periodontal disease and the infection after probing the mandibular, the suspected case that is necessary bone loss c

u advisable to take radiographs of the wrist to determine whether the mandible is well aligned or whether it has undergone a pathological fracture. These radiographs should be taken prior to the scale and polish procedure.

Description	Abbreviation/symbol
Calculus – heavy	CH
Calculus – moderate	CM
Calculus – light	CL
Gingivitis – none – healthy	G0
Gingivitis – mild – marginal redness	G1
Gingivitis – moderate – bleeds on probing	G2
Gingivitis – severe – spontaneous bleeding	G3
Mobility – slight	M1
Mobility – moderate	M2
Mobility – marked	M3
Furcation – probe into furcation	F1
Furcation – probe passes into furcation but not through	F2
Furcation – probe passes from buccal to lingual/palatal	F3
Fracture	Fx [illegible]
Pulp exposure	PE
Enamel defect	ED
Missing tooth	MI
Oronasal fistula	ONF
Retained root	RR
Gingival hyperplasia/overgrowth	GH
Abrasion	AB
Attrition	AT
Secondary dentine	SD
Tertiary dentine	TD
Periodontal pocket depth	x mm
Feline odontoclastic resorptive lesion	FORL
Caries	CA

Table 2.[illegible] Commonly used abbreviations in dental charting.

Routine prophylaxis (scale and polish)

Moderate to heavy calculus can be removed using calculus-cracking forceps and an electromechanical scaler (Figure [illegible]). The use of calculus-cracking forceps is time saving but they must be used appropriately and carefully as severe damage can be caused to the tooth and gingiva. The forceps are applied to the calculus in such a way that cracking force is directed at the calculus in relation to the tooth surface (Figures 2.4[illegible]). Under no circumstances should the tooth be pinched between the jaws of the forceps. In cats suffering from odontoclastic resorptive lesions the crowns of an affected tooth may break off during an attempt to remove heavy calculus which may be covering the compromised crown. If resorptive lesions are noted on other teeth it is advisable to use other means to remove gross calculus. Once the gross calculus has been removed using forceps, the remainder can be removed using manual (Figure [illegible]), electromechanical (Figure 2.4[illegible]) or pneumatic scalers.

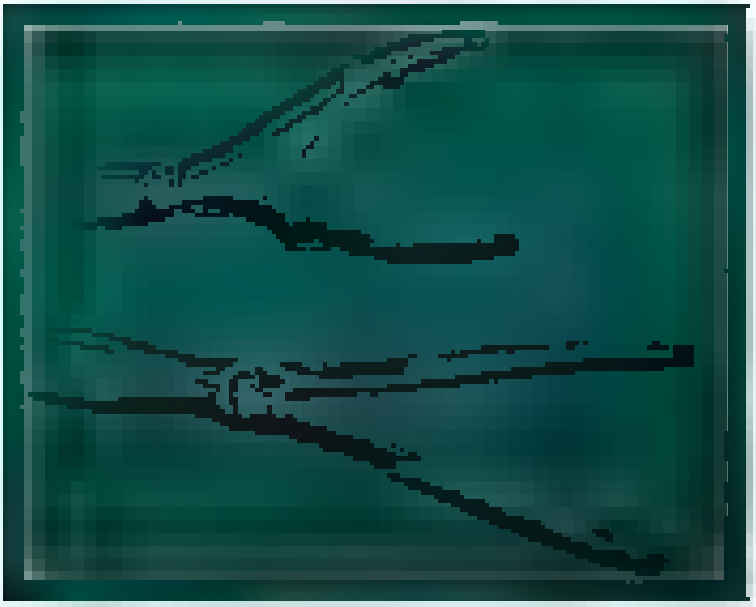
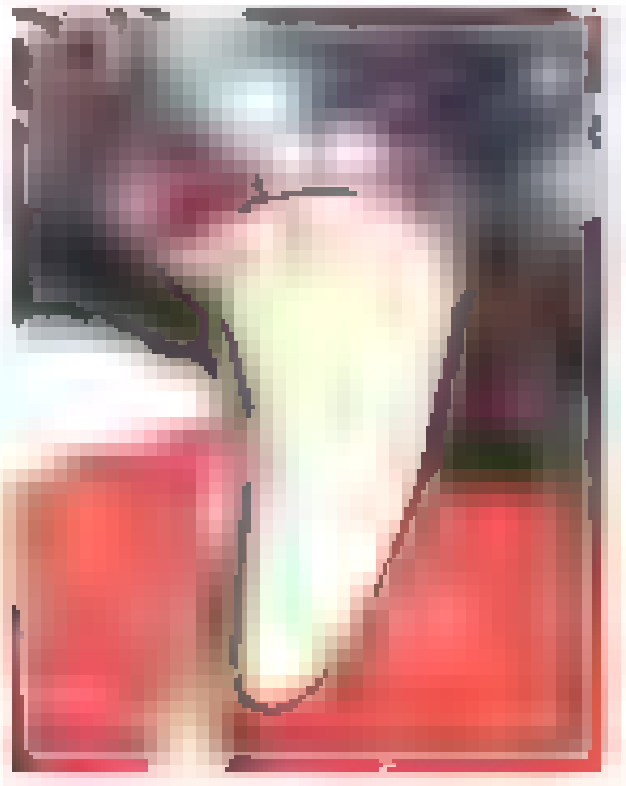


Figure 2.36 Shearing forces dislodge the calculus from the crown of the tooth

Figure 2.37 Periodontal calculus may begin to pump a significant amount of bacteria

Electromechanical scalers must be used with [illegible]. First, the ends of these scalers must never be applied perpendicular to the tooth surface as they will damage the tissues. Second, they must be powered at [illegible] with sufficient water flow to keep the water tip and tooth from becoming heated and



Black calculus debris away. The scaler tip should not be kept within a deep pocket for prolonged periods as this may lead to damage to the gingiva and possibly the pulp. Ultrasonic tips for sub-gingival scaling have also been designed which deliver irrigant to the tip keeping it cool and flushing debris from within

Figure 2.68 Paravertebral trave
applied to the scapula (b) to spread
more than about right (c) and to a
medial aponeurotic origin) may result

Figure 2.69 A gentle, sustained pull
or along the body's long axis will release
nuscle, paving the way for subsequent
dissociation. Generally, both of these
extremities can be moved in two
simple ways (as pull or push)

b> pectoral. A gentle, sustained pull, or shear directed laterally along the body's
ovement, such as in the case of the latissimus dorsi, will release the pectoral muscle,
gregral mobilization (Figure 2.69). Some sub-groups, such as the clavicular
ectoral, can be moved in two simple ways (as pull or push) or along the body's
ong axis (as shear). Both of these movements will also reveal whether the shoulder
ould need to be differentiated

Figure 2.42 Plaque disclosing solution should be sprayed after scaling and prior to polishing to improve polishing efficiency.

from contaminated areas on tooth surfaces and soft tissues. When scaling teeth with sonic or ultrasonic devices on periodontally involved teeth, it is recommended that a chlorhexidine irrigation be used rather than spraying water or air alone, which would damage the tooth pulp.

Once the calculus has been removed, a plaque-disclosing solution can be applied to the tooth surface to reveal the plaque, enabling the teeth to be polished more efficiently (Figure 2.42). When plaque-disclosing tablets are used, care must be taken to ensure that the patient is not allergic to the dyes. Sufficient rinsing time must be allowed so that the tablets are completely dissolved. Disclosing paint must be used on a tuberculosis and hepatitis clientele. The patient should be discharged immediately to remove supragingival plaque. (Figure 2.43) The appearance of the spread of bacteria on tooth surfaces, as revealed by the disclosing agent, will cause the gum-related pulpitis. Teeth are sometimes stained extrinsically or intrinsically, requiring more aggressive scaling or polishing. Gum recession will not occur, and tooth damage can be prevented. A rotating attempt to remove (Figure 4.41)

When all tooth surfaces have been scaled and polished, the debris and polishing particles should be flushed from the mouth using the three-way air-water syringe (Figure 4.4). Chlorhexidine gluconate oral rinse can be applied as a supplement, apart from professional application, if they are allowed.

All further treatment is needed, which includes the taking of radiographs, then they should be taken at this stage. Radiographing teeth which are covered in calculus will result in artifacts and should only be performed when periodontal new treatments are suspected.

Figure 2.45 The three-way syringe is used to flush or irrigate the root canal system with water to remove debris from the mouth.

Further reading

Gordon, D.A. and Fontana, S. (2021) Manual of Small Animal Dentistry. BSAVA Publishing, Gloucester, UK.

Holmstrom, S.E., Frost, P. and Eisner, E.R. (2004) Veterinary Dental Techniques for the Small Animal Practitioner. 3rd edition. W.B. Saunders Company, Philadelphia.

Riggs, R.B. and Johnson, H.N. (1977) Veterinary Dentistry Principles and Practice. Lippincott Raven, Philadelphia.

The Dental Room

The veterinary dental operatory, commonly known in practice as the dental room, should be a clean space with the appropriate and most important piece of equipment being the dental unit. The dental unit should have an air-extraction system which will create a negative pressure within the room. This is to ensure that aerosolized micro-organisms are discharged to the outside of the building in such a manner that they do not compromise public safety. It should not be possible to recirculate the air within the building. A fresh air supply should ensure that the air is changed up to ten times per hour.

The floor in many typical dental working areas consists of a multitude of different materials which are simple to wipe clean and make it very difficult

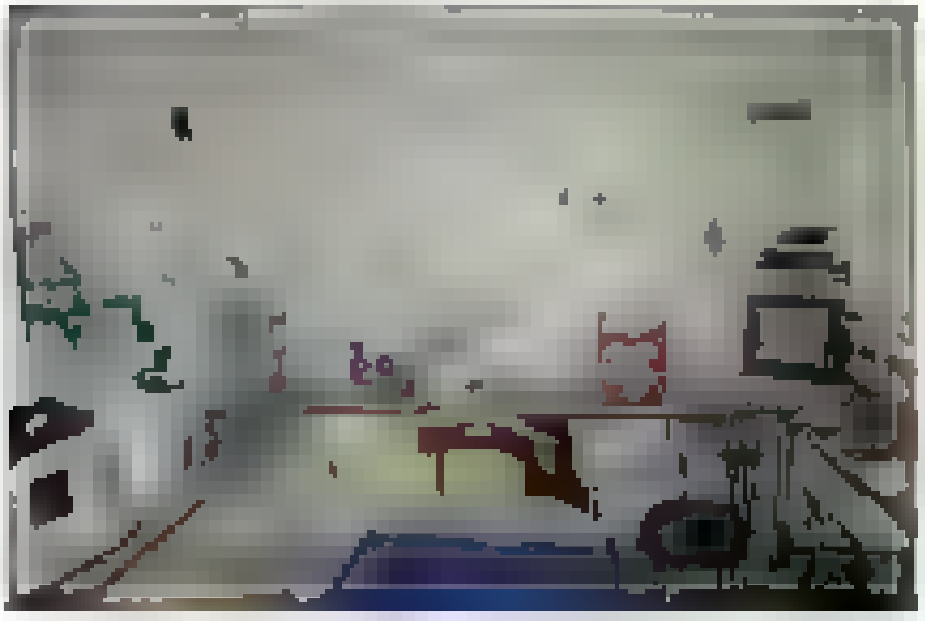


Figure 1 The dental operatory should comprise a considerable part of the maintenance and an assistant's table as well as a place for the patient, an anesthetic machine, dental radiographic unit and a high-volume dental unit and air compressor that would be kept outside the room.

Figure 1.2 An effective air extraction system should exhaust dental waste to the outside without compromising public safety.

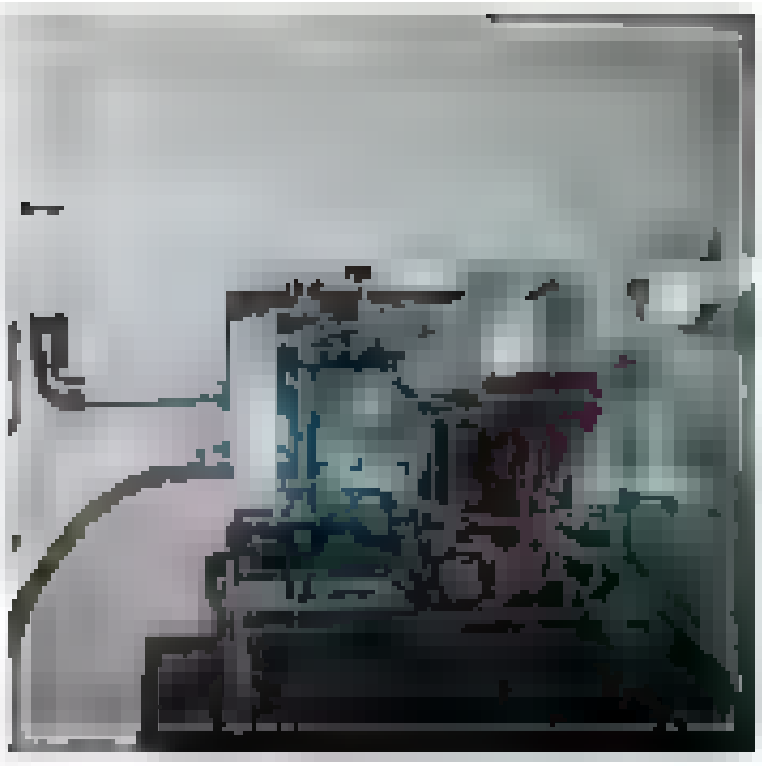


Figure 1 Exposed anaesthetic gases should also be scavenged from the anaesthetic circuit and expelled from the room via the system installed for general anaesthesia rooms

should also be impermeable and easily cleaned. The tiling of walls would be a practical option.

Since radiography will be performed in the dental room as well as the laboratory, one should take measures against unnecessary radiation exposure.

Health and safety considerations

The health of the assistant, surgeon, laboratory technician and the patient are to a certain extent interdependent and necessary precautions should be taken to minimize exposure to hazards. The necessary surgeon and nurse should wear protective spectacles to minimize ocular exposure to aerosol-borne micro-organisms and splatter, as well as debris generated by sealers and high-speed dental equipment. High-speed burs may fracture and their projectiles can cause serious injury. Dust spectacles are not considered to provide adequate safety as they can become loose when exposed to a projectile. 'Wall' spectacles could also be inappropriate for ocular protection. Appropriate surgical masks should also be worn to prevent aerosol inhalation of pathogenic micro-organisms. These masks must be considered disposable at the end of the procedure and should not be worn outside the operating theatre as well. Suitable protective gloves should always be worn during surgery.

It is also recommended that patients' eyes should be protected by an ocular lubricant gel, depending upon the length of the procedure, that may need to be repeated. Covering the patient's face with a drape or sterile towel will also reduce the aerosol. A correctly placed saliva ejector and high-volume evacuator will help draw fluid away.

Placement of an intravenous cuffed endotracheal (ET) tube is essential to prevent the lower airway from debris, blood, saliva and toothpaste. The ET

[illegible] aim is to [illegible] [illegible] [illegible] reducing contamination of the work area and [illegible] inhalation of aerosolized [illegible] organisms by the patient. A disposable pharyngeal pack will prevent blood and debris from accumulating in the pharynx.

Hand instruments

The periodontal probe is used to [illegible] and [illegible] gingival sulci [illegible] deep in dogs and [illegible] in cats [illegible] normal and periodontal pockets. The periodontal probe is a blunt ended instrument which should have [illegible] graduated [illegible] several [illegible] and graduations of known dimension (Figure 3.6). This enables the clinician to record the findings in the chart [illegible] accurately. A Williams [illegible] periodontal probe is commonly used in veterinary dentistry [illegible] (Figure 3.7).

Dental explorers are sharp-tipped instruments of various shapes used [illegible] to explore the tooth [illegible] and to explore [illegible] to [illegible] after scaling is completed. The explorer will reveal sub-gingival [illegible] which should be differentiated from sub-gingival

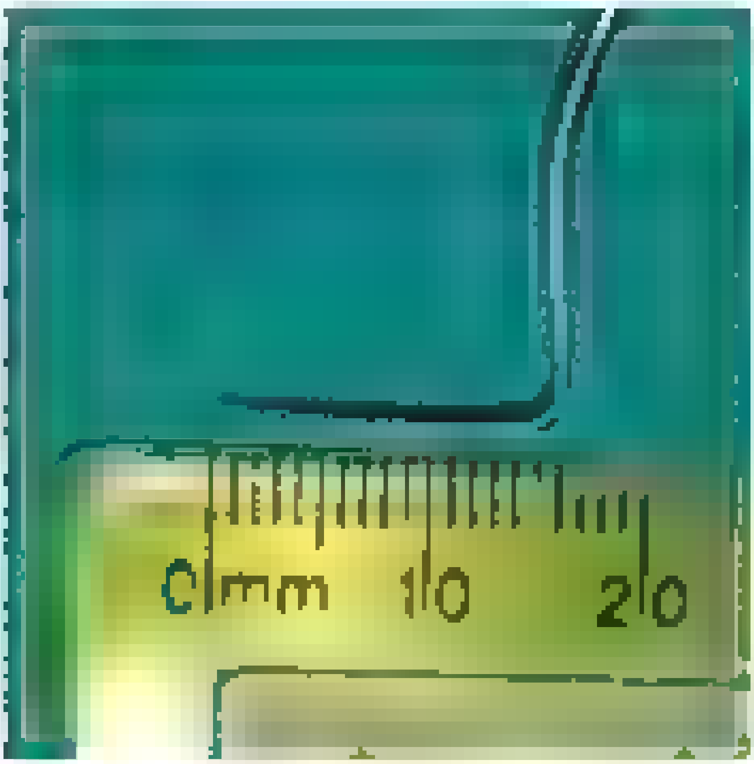


Figure 3.6 The graduations on the probe should be of known dimension for accurate recording of measurements.

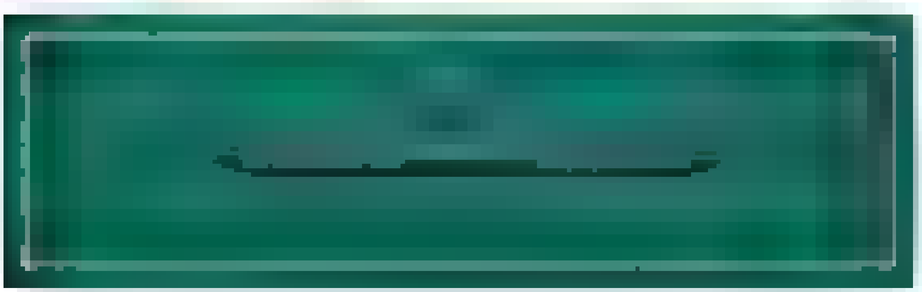


Figure 3.7 A WHO [illegible] periodontal probe and dental explorer combination

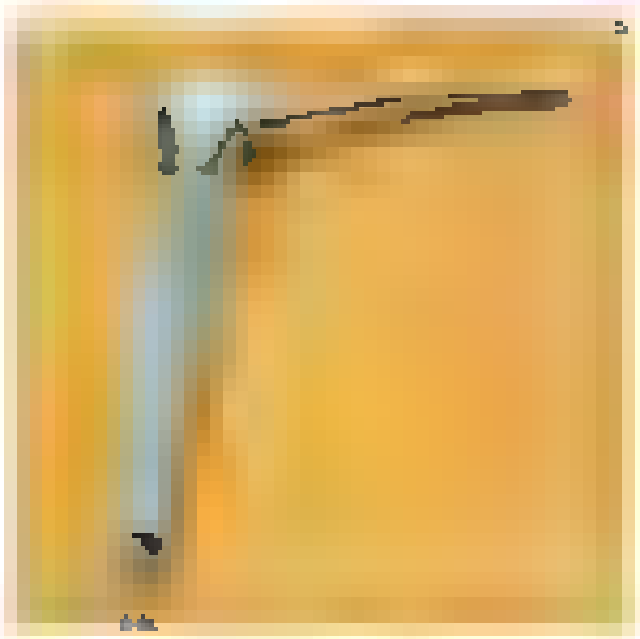


Figure 3.3 [illegible]

[illegible] [illegible] [illegible] [

Figure 5.19 Periodontal examination and treatment instruments. (a) Periodontal probe and explorer. (b) Dental mirror. (c) Dental calculus and plaque.

dental mirror may also aid in visualization of the distal aspects of teeth but also can be used to shine light onto specific areas. It can also be used as a tissue retractor. The mirror can also be used to visualize the reverse aspect of the mirror image. There will be a tendency to wipe the mirror against the inside of the patient's cheek which will prevent it from fogging (Figure 5.19c).

There are many different patterns of hand instrument available for use in dental animal dentistry, each having been designed for use in certain situations. Hand scalers are used to remove calculus from the supragingival surfaces and curettes are used to remove subgingival calculus. Scalers should be used supragingivally rather than subgingivally as they may damage the soft tissue attachment. Ultrasonic and sonic scalers are also available for supragingival descaling. Scalers and curettes must be used with care to ensure that the tooth surface is cleaned but not damaged. Calculus which develops around grooves may also be removed with care. In some cases, using the edge of a curette to gently probe the grooves can help to identify calculus that is hidden from view. Ultrasonic scalers are also available for removal of subgingival calculus. However, they can cause damage to soft tissues if not used correctly and should be avoided in periodontally diseased pockets.

Once all the calculus has been removed, the tooth surface, supragingivally and subgingivally, should be polished. Polishing is the last attempt to remove any remaining plaque from the tooth surface. The instrument used is a rubber cup or brush which is mounted on a slow-speed handpiece. Plaque-disclosing solution may be applied to the teeth after scaling and before polishing to increase the effectiveness of polishing. Prophy paste or brushes can be driven by electric or air motors. When the owner of a dog does not brush their dog's teeth, a dental visit, as

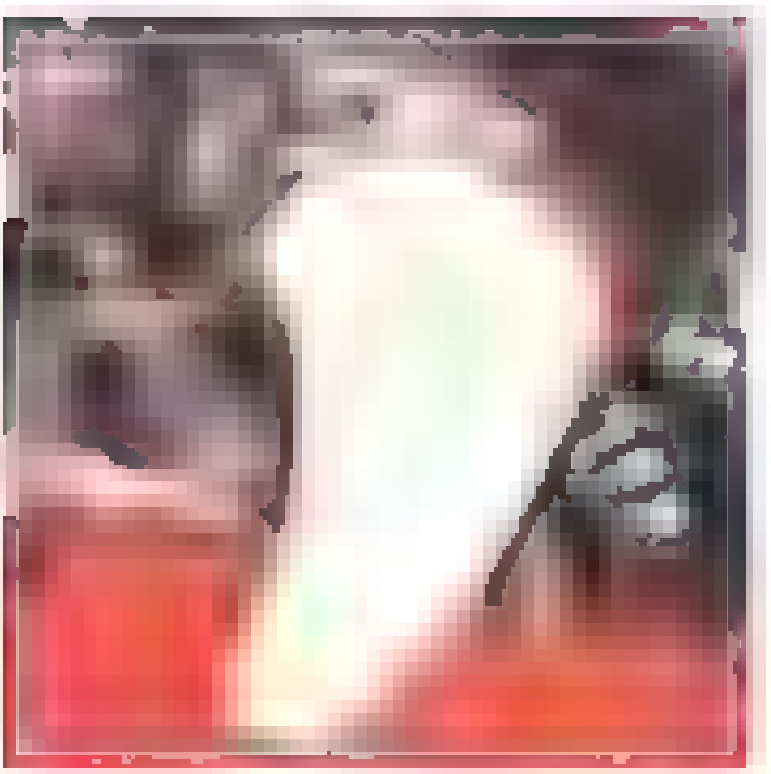


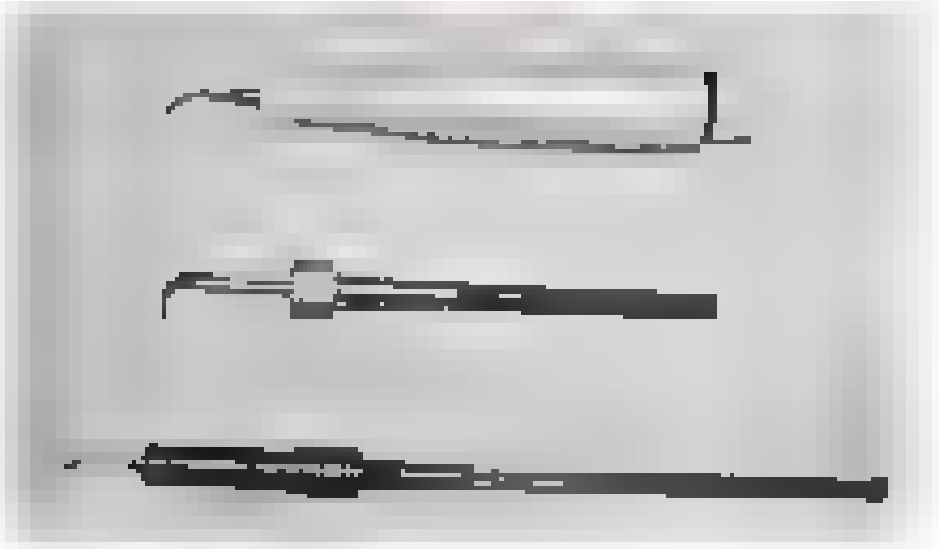
Figure [illegible] A turntable being used to perform weighing of cartridges

electromotor driven unit can be more effectively measurement bottle during with a latch key coverup used to polish work. Hose shaking using a [illegible] measurement electronic is not beneficial but is suitable for dental bromocaine is be performed by the operation.

Power engine

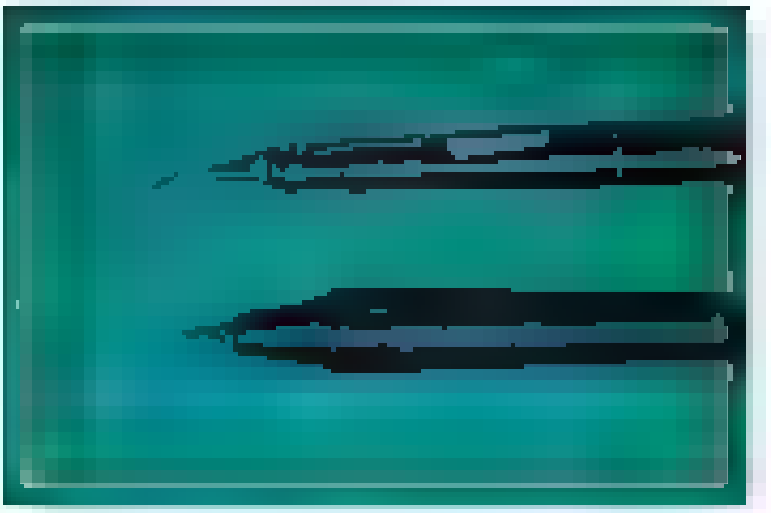
Mechanism

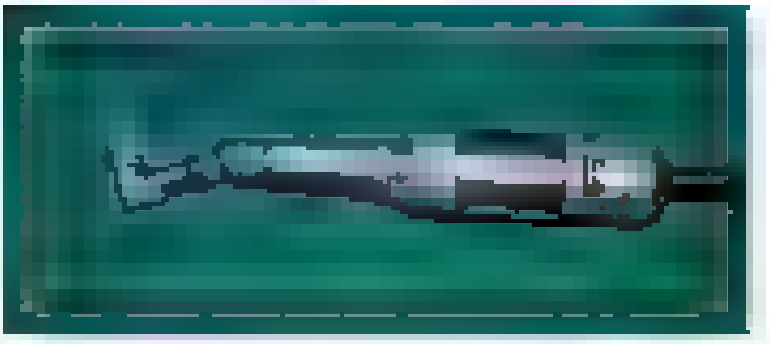
Electromechanical valves are divided into two categories: magnetomotive and piezoelectrical. In the former group an electric current applied around a ferrite rod or a metal mask. Under the attracted upper resistance material and under group an electric current applied to a conical cradle is determined by the current and resistance at the water cap in the base wires. Some magnetomotive valves have a smaller amplitude of oscillations which allows continuous coverage of the work surface. Magnetomotive valves have a flat wheel oscillation pattern, while piezoelectric valves have a linear oscillation pattern. Magnetomotive valves could be arranged circumferentially around the working piezoelectric valve may exist various of such one of the linear valves. The armature is the armature a small oscillation valve which oscillates on the work surface causing to several of electric is can use. Here screen damage the is coordinate of reproduction in many caused in plane. Some magnetomotive and piezoelectric valves have up which can be used subprogrammed processor is delivered to the speed of the valve preventing external damage to the work of graphs. The frequency of these valves is typically in the range of [illegible] to [illegible] Hz. Figure 2 and 3.



Bank

Pollution





brushes (Figure 11). Motor-driven brushes can remove contaminants by applying a soft surface and should therefore be used sub-gingivally. Natural bristle should be used in preference.

When using prophy cups sufficient pressure should be applied to the cup to cause it to become slightly inverted. Sub-gingival prophylaxis is carried out using a light touch. Ensuring proper patient care is carried out rather than rushing to complete the procedure. If the prophy head rotates in unison with the hand piece, reduce the pressure and speed adjustment ring at the base of the hand piece to slow the rotation. This will change the direction of rotation and keep the prophy head in place (Figure 9). Some prophy heads oscillate rather than rotate.

Figure 5.19 The original design of the 3M Pana-Pak straight-grip device as well as several interchangeable tips for various proximal approximating procedures.

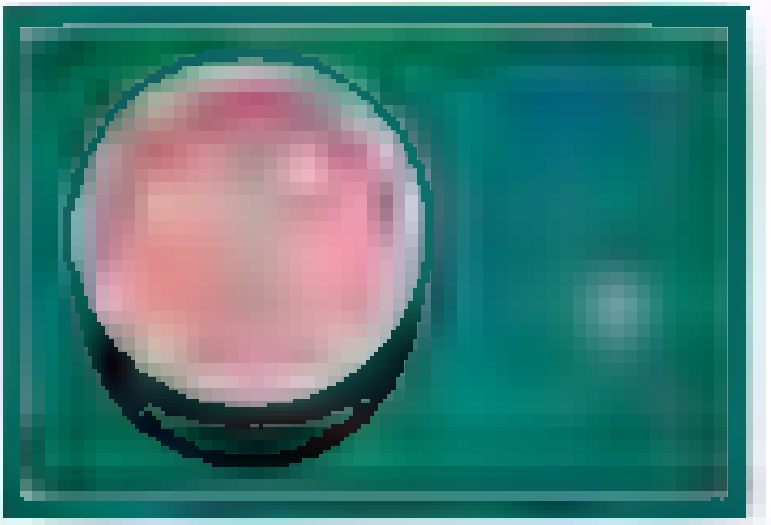


Figure 5.20 Prophy angles available for multi-dose or individual patient use. Note the presence of a rubber cup on the tip of the single-use prophy angle to prevent cross-contamination.

Prophylaxis paste

Dental prophylaxis pastes are available in numerous flavors, consistencies and textures. A medium abrasive texture is usually used as coarse abrasive pastes will damage the enamel surface causing it to wear, plaque retention and should therefore not be used. Although dental prophy paste is available as multi-dose containers, single patient pots are preferable in order to prevent cross-contamination (Figure 5.20). Single aliquots can be decanted from a multi-dose pot and placed in an appropriate receptacle. Any unused paste should be discarded from a multi-dose pot following the prophy cup during the polishing procedure.

Three-way syringe

The three-way syringe is a very useful piece of equipment when performing various dental procedures. The air-and-water syringe is used to dislodge and clear debris as well as wash away blood from the patient's mouth. A gentle pulse of air directed over a tooth surface progresses along the crown of the tooth and

[illegible]

Slow-speed air motor

[illegible]

High-speed turbine hand piece

[illegible]

Dental burs

[illegible]

Figure 5.23 The high-speed hand piece is held along the machine axis grip with the tooth-type steel at a right angle to adjacent structures.

fragments. A small brass wire brush should be used to remove debris from the bur while it rotates in the air to avoid damaging the abrasive surface. A nylon wire brush can be used to clean tooth and bone debris from diamond-coated wheels and wheel points. It is important to remember that the wheel flow is adjusted appropriately to ensure that the teeth are not damaged by excessive heat. Dental burs should be stored as in Figure 5.23.

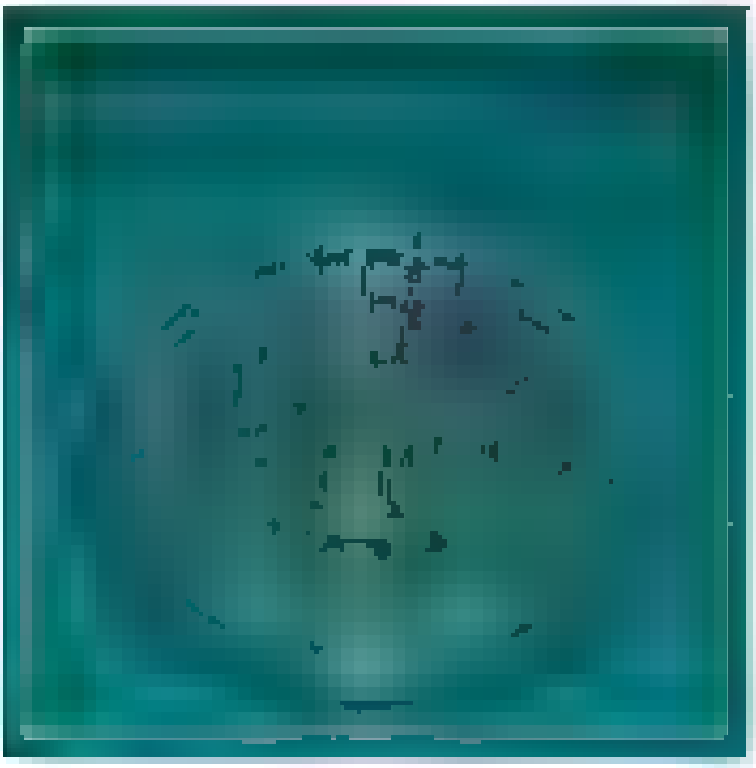


Figure 5.23 Dental burs should be stored in a bur stand.


b.

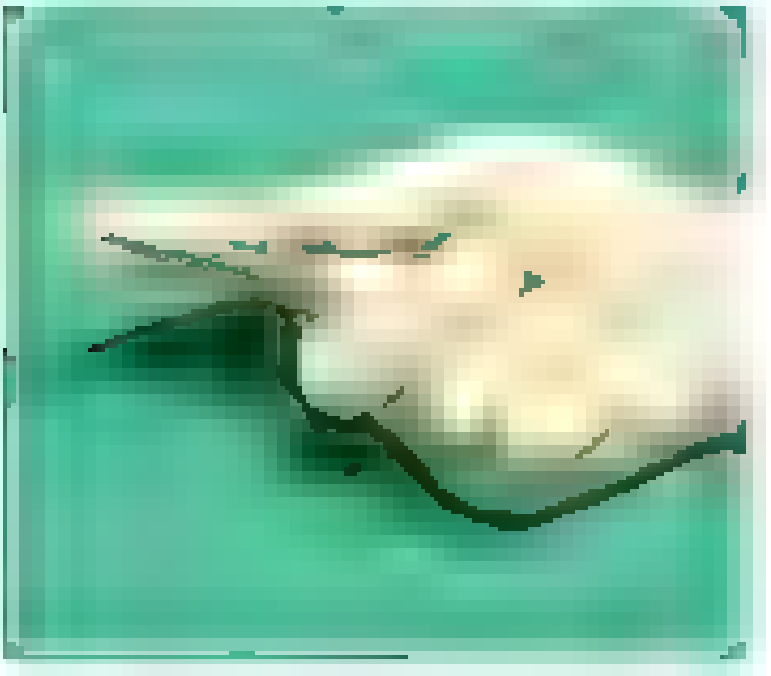


Figure 3.35 and 3.36 Several instruments are held in the palm grip with the index finger extended along the shaft of the instrument. Notice the index finger should not touch the strings.

Instruments like the bass are held with the left hand (Figure 3.37 and 3.38). The instrument is balanced between the body and the shoulder. You can apply downward and outward pressure with your fingertip. When learning the art of vibrato technique, gentle rotational pressure is to be applied and released. It is important to note that a small space has been created between the neck and shoulder. Your shoulder is used to further balance the instrument. Elevation increases natural tone, however, compromises comfort and can lead to discomfort. Avoid lifting your shoulder excessively. Proper posture and instrument placement is crucial to maintaining the necessary support for playing a new instrument (Figure 3.39).

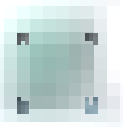


Figure 3.37 Acrylic mouth prop. Prop must be placed in the mouth on which a patient can be operated using a rotary drill. The top of mouth prop will break the drill if it comes into contact.

Dental prophylaxis

Routine dental prophylaxis includes removal of plaque and calculus followed by polishing of the supra- and sub-gingival tooth surfaces. Once the animal's mouth has been examined and assessed, the teeth and oral cavity should be cleaned using an ultrasonic scaler. The teeth are often marked and prepared prior to other treatments being performed, except in cases with severe periodontal disease where the taking of radiographs is indicated before the scale and polish procedure to prevent iatrogenic root fractures. Gross calculus can be removed from the tooth surface using curettes, removing calculus deposits (Figure 3.38). Curettes should be used with long, sweeping strokes to avoid damaging the tooth or gingiva. The jaw of the forceps is positioned in the gingival sulcus of the tooth while the tooth is placed on the gingival aspect of the calculus. The resulting shearing force applied to the calculus and tooth when the forceps are closed dislodges the calculus from the tooth (Figure 3.39). The tooth should never be 'pinched' between the jaws of the forceps as this can result in tooth fracture. Once the majority of the calculus has been removed, the remainder can be removed using sonic or ultrasonic instruments (scalers). When the calculus is removed, the operator should ensure the scaler is not left in one position for too long as heat damage to the tooth surface or pulp could result. A generous flushing of the water (anti-splash) should be used with all of these devices and will keep the tooth cool. Periodontal pockets created by the scaler tip are better at dislodging calculus and damaging plaque bacteria. Should the scaler be dropped accidentally, it should be returned to the manufacturer for evaluation, as even 'silent' tips do not scale effectively. When the operator is satisfied that all calculus has been removed, plaque-disclosing solution can be applied to the teeth to reveal plaque. This will help make polishing more thorough.

The prophy cup or brush should have light pressure at low speed applied to it as more vigorous scrubbing can cause thermal injury to the tooth pulp. The prophy cup or brush should start

Figure 3.38 Calculus marking beneath the gingival margin. Note the irregular, calculus-laden surface of the tooth. Such deposits may be responsible for bleeding on probing. The underlying periodontal pocket lining may be severely damaged.

Figure 3.39 Calculus deposits removed by ultrasonic scaling. Note the smooth, clean tooth surface.

sufficient pressure applied to the scaler during periodontal debridement to remove calculus deposits. Polishing can produce the tooth surface that the plaque accumulates more slowly and becomes contaminated more slowly.

Debridement of root canals should not remove more than a single layer of dentine. During this procedure, the operator must take care not to perforate the root canal wall.

[illegible]

Routine maintenance of prophy equipment

Sharpening of hand scalers and curettes

[illegible]

Maintaining scaler tip angle

[illegible]

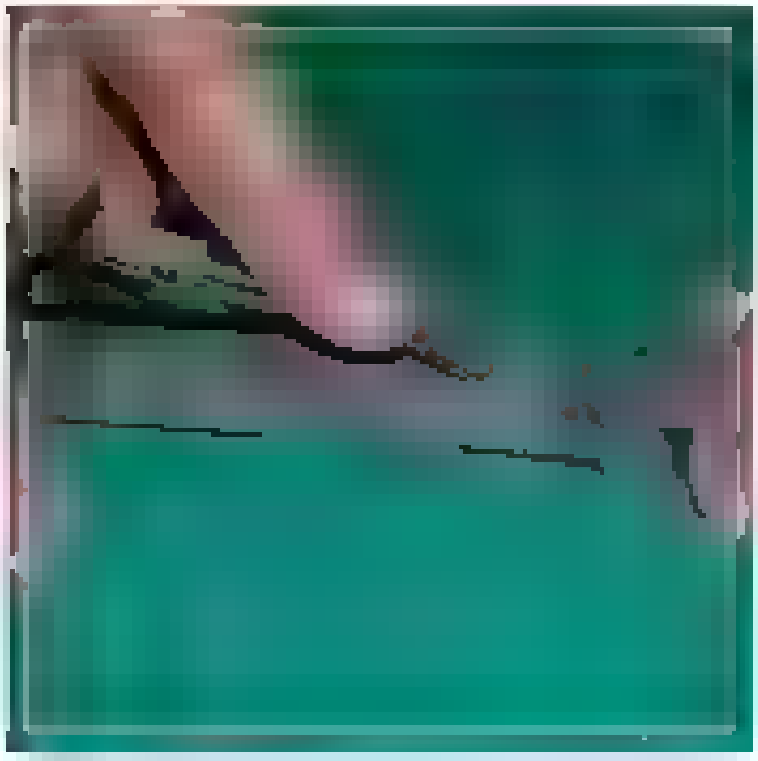


Figure [illegible] Sharpening a metal [illegible]

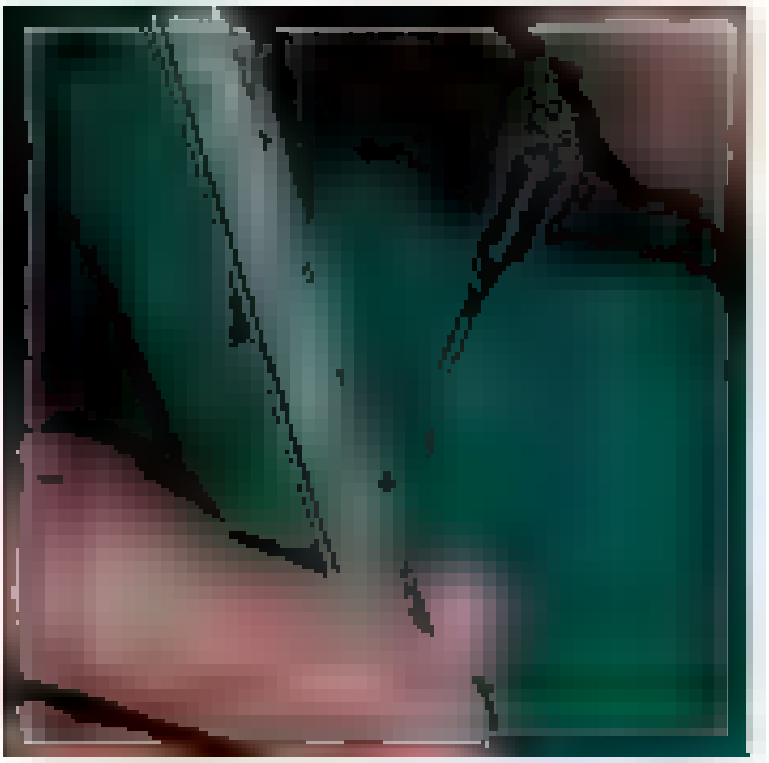


Figure 3.31 Sharpening a dental scraper. Diagonal motion is used to keep the surface of the cutting edge square to the surface of the stone.

Figure 3.32 Sometimes, when the edge is dull with burnished metal, it can be hard to see the edge. Here, a dull edge is shown (left) and after sharpening (right). Notice how much more reflective the edge is on the right.

because wear and the edge must be replaced at the manufacturer's recommendations. Figure 3.31 shows a scaler being dropped and the edge becomes blunt as a result. It should be examined to see if replacement or resharpening is necessary. When resharpening the hand piece, care must be taken to avoid damage to the magnetostrictive insert. Excessive pressure can cause

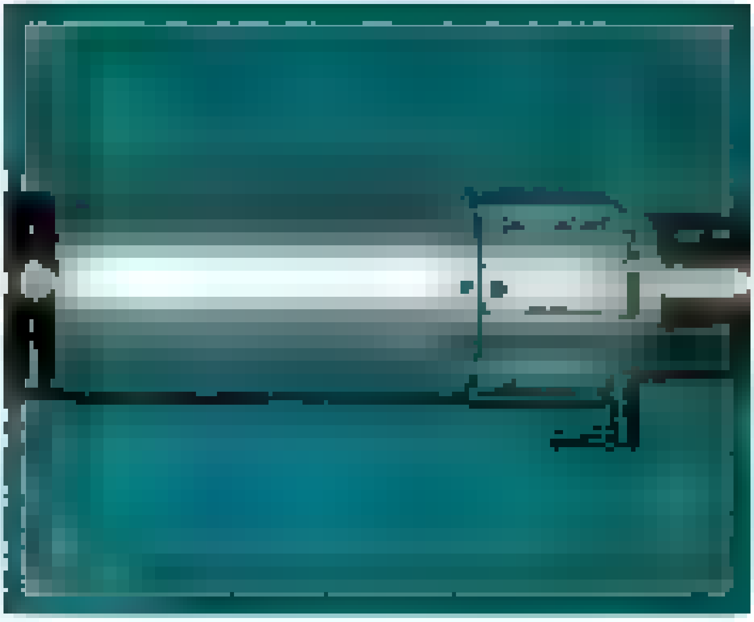


Figure [illegible] The direction of rotation at the base of the air motor must be set to [illegible]. Hair and other foreign material can be unwound from the prophy head by changing the direction of rotation.

Maintenance of polishers

The R-type fitting of the air motor as well as the contra-angle polishing attachment must be oiled on a regular basis for optimum function. The small flange at the base of the snap-on button may accumulate material, including hair. This material is easily removed by unscrewing the prophy button. Sometimes by reversing the direction of rotation of the head the material can be unwound (Figure [illegible]).

Maintenance of high-speed turbines

The high-speed turbine must be oiled regularly according to the manufacturer's instructions since over or under oiling can be detrimental [illegible]. Some turbines may be subjected to autoclave sterilization while others may be sterilized using [illegible], depending upon manufacturers' instructions. The turbine must never be run without a bur or blank in the chuck as this will cause severe damage to the turbine head. Oil is placed in the narrower of the two large holes at the back of the hand piece (Figure [illegible]).

Sharpening luxators and elevators

Luxation instruments are sharpened [illegible] a fine stone, with the concave part of the instrument applied to the sharpening stone (Figure [illegible]). It is essential that the curvature of the sharpening stone is the same as that of the luxation instrument or it will be damaged irreversibly. If the curvature of the sharpening stone [illegible] that of the luxation instrument it will become flattened and lose its shape.

Elevators are sharpened on the [illegible] stone at a low acute angle. The convex face of the elevator should be placed on the sharpening stone as the [illegible]

Figure 3.34 Rotary dental equipment must be lubricated according manufacturer's instructions using an approved lubricant. Over-lubrication can be detrimental.

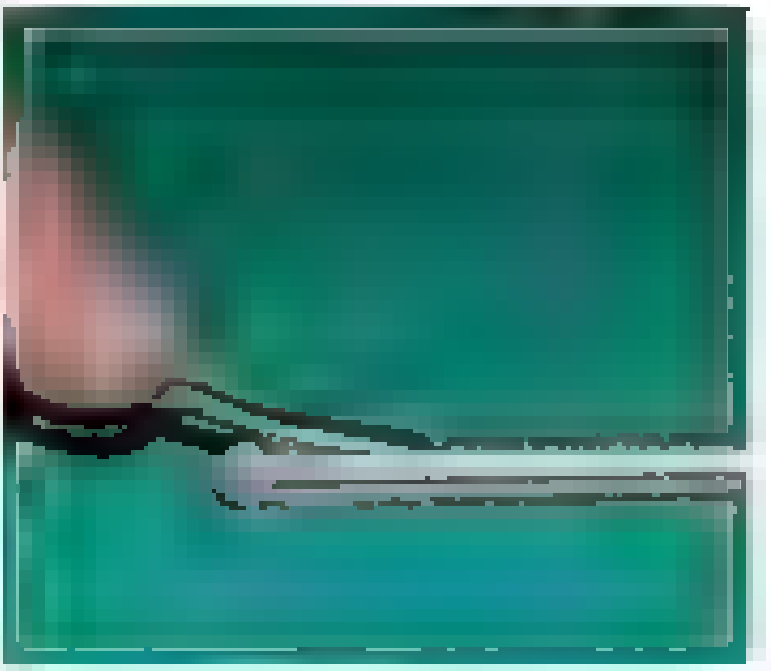


Figure 4.15 Scalpel blades are characterised on their convex surface using a sharpening stone at the required angle. The blades are sharpened up pushing them along the sharpening surface using a sharpening device or manoeuvre as well shown in the list of instruments.

inclination and using a back-and-forth wrist action, gently 'wiped' across the tissue (Figure 4).

Sharp elevators and extraction instruments are less likely to inflict damage as they engage the ligaments and bony side of the alveolus bone which would immediately adjacent soft tissue (Figure 4).

Further reading

[illegible]
[illegible]
[illegible]

Indications for dental radiography

It is not possible to practise veterinary dentistry to an acceptable standard without using radiography as an aid to diagnostics, for treatment planning and monitoring.

Discoloured, fractured, clinically missing, abnormally shaped or placed teeth and those [illegible] should all be radiographed. [illegible] teeth [illegible], a radiograph should be obtained. Depending on the results, the treatment plan may need to be modified. For example, the tooth may have [illegible] roots, or it may have [illegible] requiring [illegible] extraction than [illegible]. Swelling in the [illegible] periodontal [illegible] radiographed [illegible]. Radiography also gives an indication of the [illegible] of the periodontal [illegible], the teeth [illegible] the bone [illegible] may have been [illegible] (Figures [illegible]).

Figure 6.[illegible] [illegible] with inflamed gingiva [illegible] radiographed [illegible] page [illegible] odontoclastic resorption was diagnosed in [illegible] right third premolar.

Figure 4.4 [illegible]

Figure 4.5 [illegible]

Figure 4.6 An intact first molar associated with periapical pathology following a complicated crown fracture of the maxillary right deciduous canine in the young patient

Figure 4.7 Although this intact first molar in the area of the maxillary right lateral incisor presented with the loss of the maxillary right central tooth which had a complicated crown fracture. There is the intact first molar distal to the unerupted tooth associated with the buccal root of this tooth which also had a complicated crown fracture

Figure 4.8 Intraoral periapical lesions revealed by radiographs.

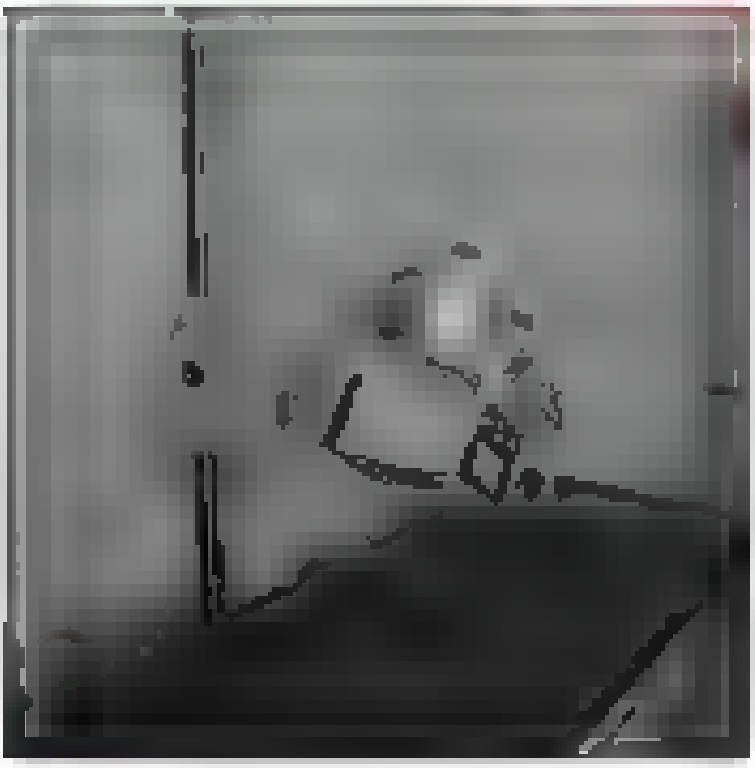
Figure 4.9 There is a circular lesion surrounding the tooth in the mandibular left quadrant, taking radiographs will reveal the extent of these lesions.

Figure 6.12 The maxillary central incisor had an acute complicated crown fracture. A pre-operative radiograph was taken to determine the extent of pulpal involvement prior to root canal therapy on the tooth. The apex of the primary maxillary canine still shows a wide root canal opening.

Figure 6.13 This carded tooth should be explored and radiographed to eliminate any pulp exposure from the fracture that occurred earlier in life.

Figure 4.16 An maxillary right lateral incisor has undergone pulpectomy but can be identified on radiography since the outline of the root can be visualized as well.

Figure 4.17 Small lesions may be radiographically undetectable due to superimposition.



Equipment

Veterinary dental radiography can be performed using the medical X-ray machines (Figure 4-9) found in most animal veterinary practices but dental X-ray machines (Figure 4-10) are more practical

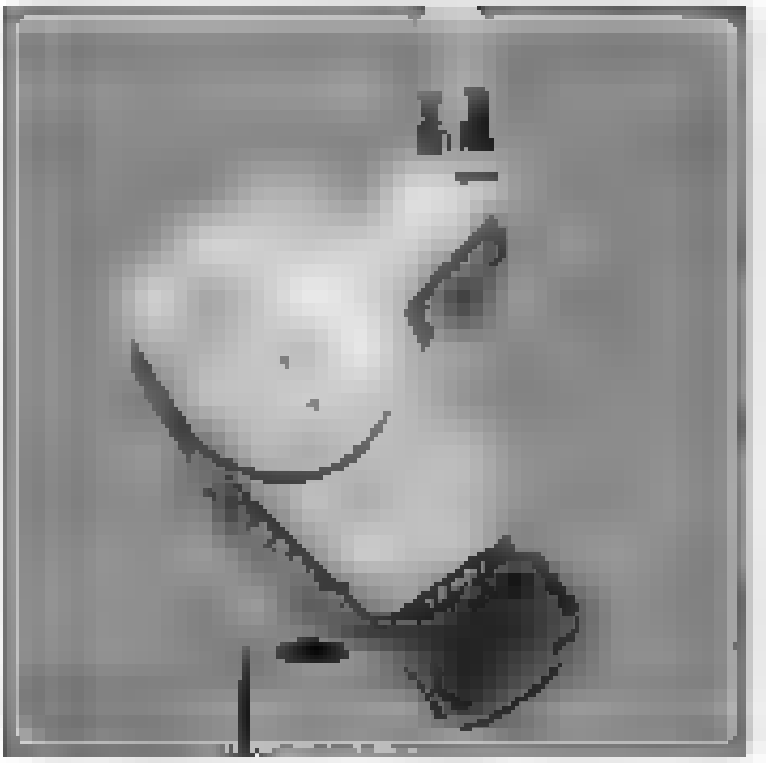


Figure 4.28 Dental X-ray machines are often positioned next to the patient and can be installed in the dental theatre.

The disadvantages of using a dental X-ray machine:

- the machine is usually situated in a separate room away from the dental room
- the unobstructed patient access between the dental and X-ray rooms is compromised under the X-ray machine
- some machines are fixed to the wall and cannot be moved if the required film-focal distance (FFD) is
- some machines are not able to rotate to be positioned for various beam angle arrangements
- time is used positioning the X-ray head in the correct position
- errors are created due to human error.

Advantages of using a dental X-ray machine:

- the FFD is fixed for consistent radiation
- time is saved
- small jobs and multiple films requiring only one exposure are easy
- machine is permanently positioned
- machine may be movable or mounted on the wall or ceiling of the dental room.

When using a dental X-ray machine it should be noted that some [illegible] and [illegible] depending upon the size of the patient and the procedure to be

Figure 4.23 Hand-developing tanks can be used to develop dental X-ray films. The film must be well agitated during processing at intervals of [illegible] to [illegible] to avoid [illegible] chemistry.

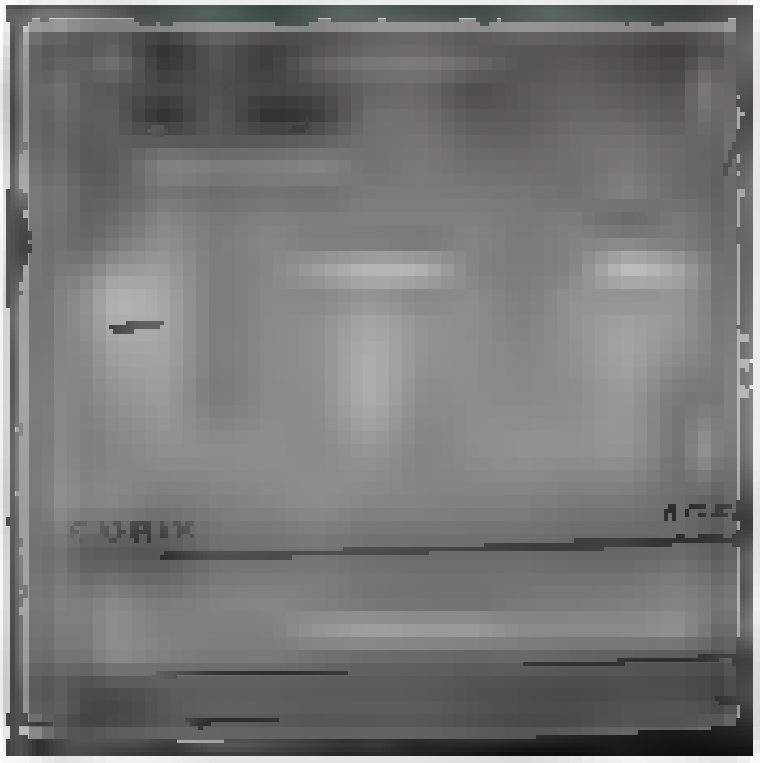


Figure 4.22 Processing chemicals can be [illegible] using the [illegible] processing solutions and used in the darkroom.

radiographed. The PPE should be about 40 cm and can be obtained either by lowering the X-ray machine head or placing an object (low table or chair) above the X-ray cable unit, which can protect a placed screen-and film cassette and can either be developed in the developing tanks (Figure 4.23) or in the dark room (Figure 4.22), or in a chemical enclosure (Figure 4.24).

Figure 4.33 Chemical darkroom are
temperature processing chemicals

Figure 4.34 Digital window provides
safe light within the processor allowing
observation of the print

Digital X-ray machines usually have a fixed kV between 40 and 150 and mA between 0.5 and 5. Exposure time is adjustable and may be set mechanically or electronically. Collimators are always used while chest radiographs are considered indispensable because of exposure dangers associated with them. X-ray machines emit low energy photons which are not much useful in producing radiographs. They increase patient radiation.

Health and safety considerations

[illegible]

Intra-oral dental film

[illegible]

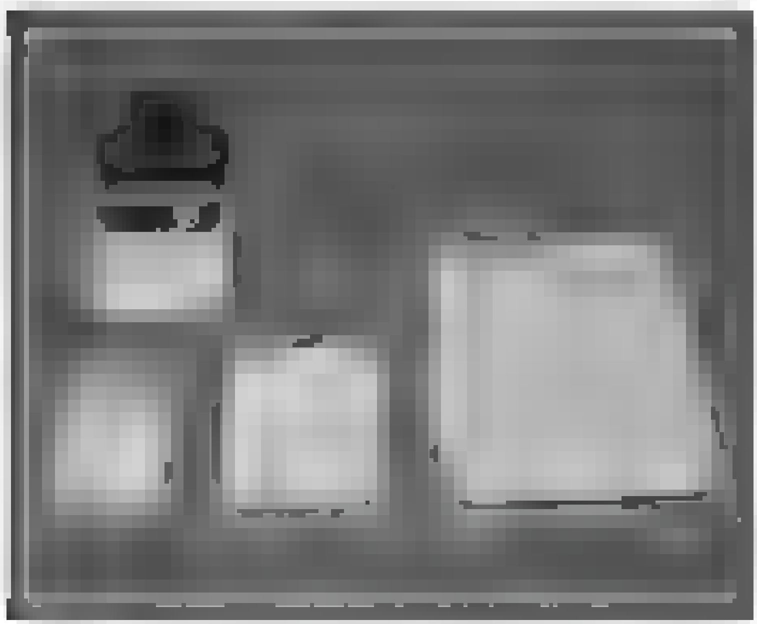


Figure 4.25 [illegible]

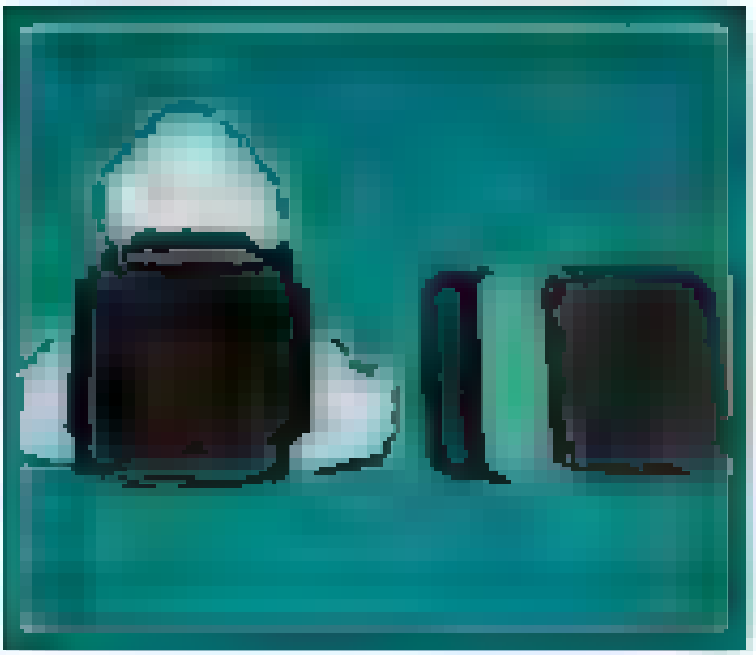


Figure 4.24 The film is exposed by black paper. Visible banding shows illumination variation and the film is ruined if not developed.

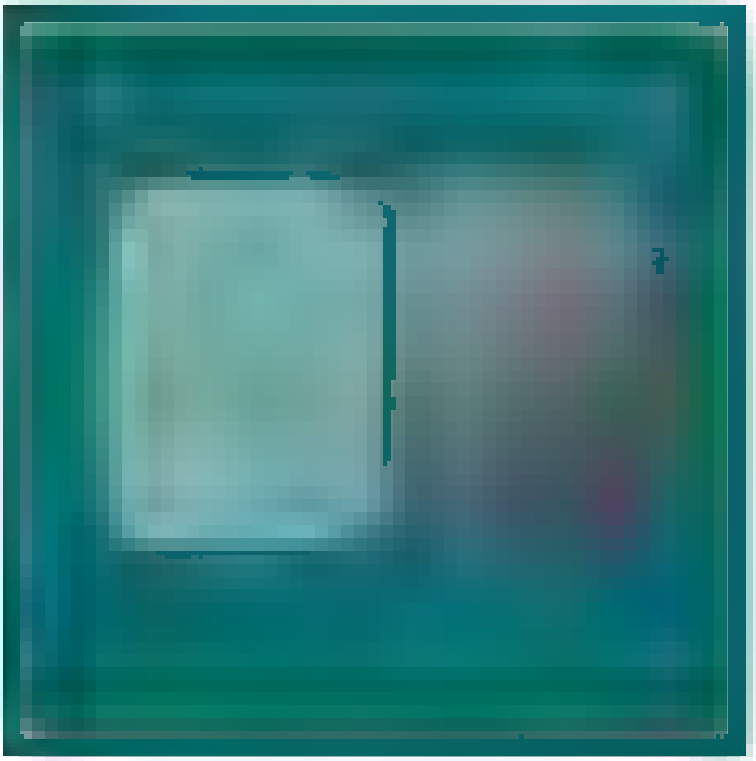


Figure 4.25 The film has been shielded from the light source and is not ruined by the processing. The film on the left is exposed but not developed.

gives an image of poor quality. Exposed film can be developed under a safelight.

Mammography films or normal radiographic cassettes can be used to take radiographs of rocks and other solid structures but can easily be damaged during processing. Severe compression of specimens can also damage the emulsion. Care must be taken when using plastic bags, as they can be used for contact radiographs.

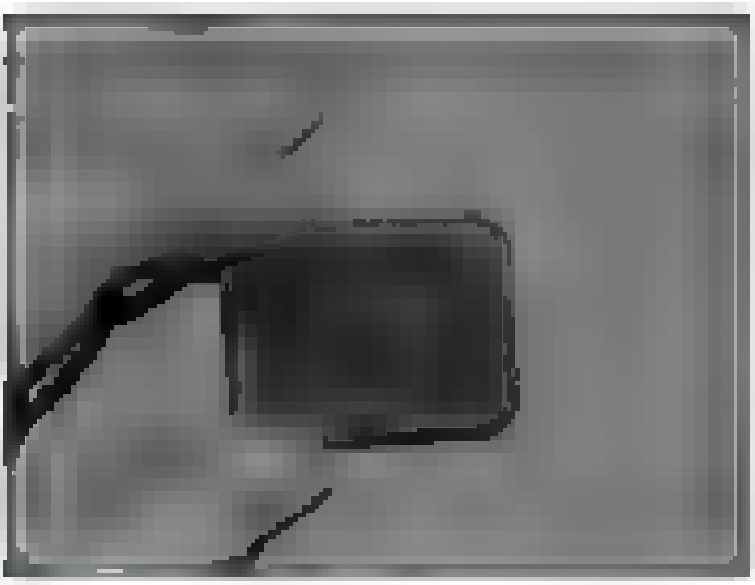


Figure 4.23 Plastic film radiograph showing an hand clamp to edges to avoid fingerprint artefacts

Film processing

Chemical darkroom ideal for developing intraoral dental films the exposed film to be processed and the processed radiograph can be viewed within minutes of being taken. There darkrooms have three or four containers within them. The two variant system contains: developer, rinse water, fixer and rinse water. The three-container system contains developer, rinse water and fixer. The film is rinsed in tank water after developing and fixing. Small temperature-safe lights should be used to help see films during processing. If these are not available, small harmless lights can be carefully switched on and off intermittently. When processing films in a process tank, the dental films can be developed in the darkroom, but they require the course of exposure to be away from the patient immediately. If the practice uses an automatic processor, the developer and fixer chemicals can be decanted from the processor and used in a clean container within the darkroom. Processing chemicals differ and the duration of developing and fixing varies according to the chemicals used. When using rapid acting chemicals developing and fixing manually take about 10–20 seconds per process. These chemicals are used at room temperature, however when the ambient temperature is low the process will take slightly longer. Other chemicals require up to 4 minutes for developing and the same length of time for fixing.

The exposed film should be handled along its edges to prevent finger grease causing artefacts (Figures 4.23 and 4.24).

Film positioning

To take a full-mouth series of radiographs of the teeth will require a minimum of ten films: six of the upper incisors and canine (maxillary) arch, two of upper premolars and molars, one for lower incisors and canine (mandibular) arch, and two of lower premolars and molars. However on

Figure 4.28 Bite-wing radiograph radiograph to the left of the midline

Figure 4.29 Illustration of positioning of intra-oral radiographic film for a bite-wing radiograph and a periapical radiograph

accessing purposes and views can be taken and, depending on the anatomy, further views can be taken (Figure 4.30).

To take a bite-wing radiograph of the premolar region will require a number four film, depending upon the size of the dog (Figure 4.31 and 4.32).

The bite-wing radiograph of the canine area will require a number three film being a fairly straight view, it may be necessary to take radiographs of the left and

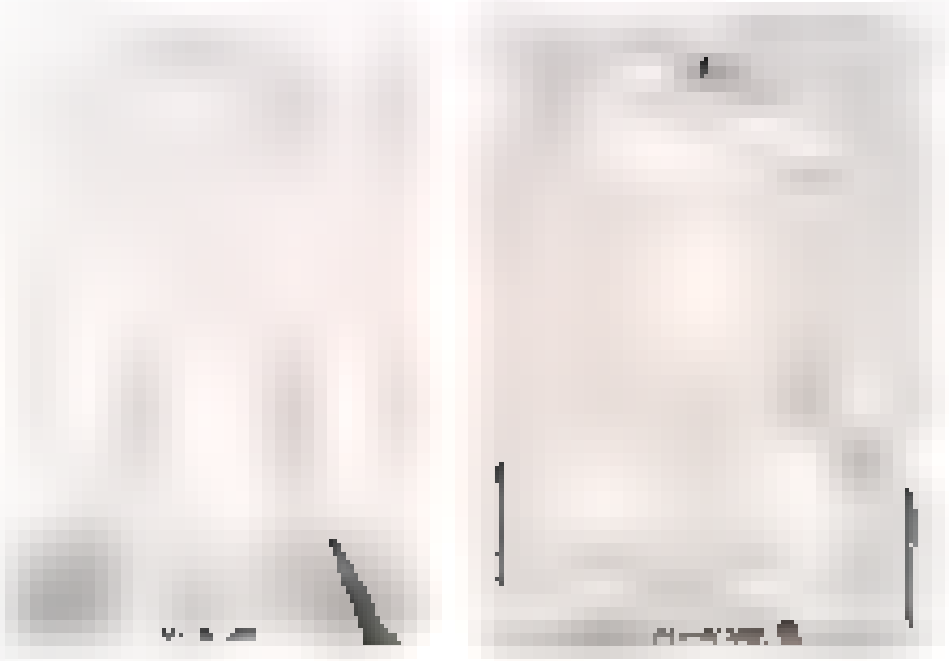


Figure 4.23(left) Illustration of positioning of right temporomandibular joint for a transcranial oblique projection.

Figure 4.23(right) Illustration of position of right temporomandibular joint for a transcranial oblique projection.

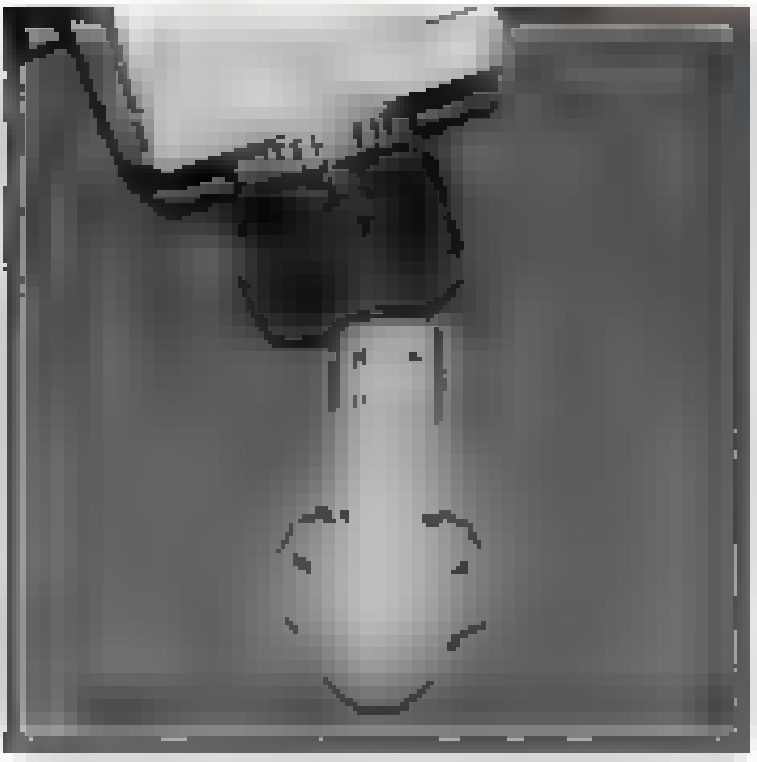


Figure 4.24 Mandible with the head rotated to the right, superimposition of the maxillary posterior teeth and

right mandibular ramus respectively. Two main superimposed shadows. Figure 4.24 and 4.25

two main examining shadows are noted, namely the parallel and curving one shadows

Figure 4.34 The view obtained by the positioning shown in Figure 4.

Figure 4.35 Illustration of the parallel radiographic technique. The film is placed close and parallel to the teeth and the incident beam is directed perpendicular to the teeth and film.

Parallel technique

The parallel technique is used to take intra-oral radiographs of mandibular teeth and also the maxillary incisors and canine teeth. The lower premolar can be included on the film in addition to the mandibular third and fourth premolar and first molar teeth are imaged using the parallel technique. The dental film is placed between the teeth and the tongue with the film projecting below the incisal margin of the mandible. The incident X-ray beam is then directed perpendicular to the teeth and film. Employing a rectangular film holder to hold the radiograph (Figures 4.36 and 4.37). The parallel technique may also

ar used in radiograph. Ca mandibular premolar teeth with the film placed in an intra-oral position. The mouth must be propped open to receive such impression or other structure on the film during radiographic (Figure 4 - 9). El case technique used, the radiograph should be interpreted accordingly as one

Figure 4.34 An film must be placed close and parallel to the tooth

Figure 4.35 Bisecting the mesial and distal teeth using the parallel technique requires horizontal placement of the film. A paper clip is used for identification

Bisecting-line technique

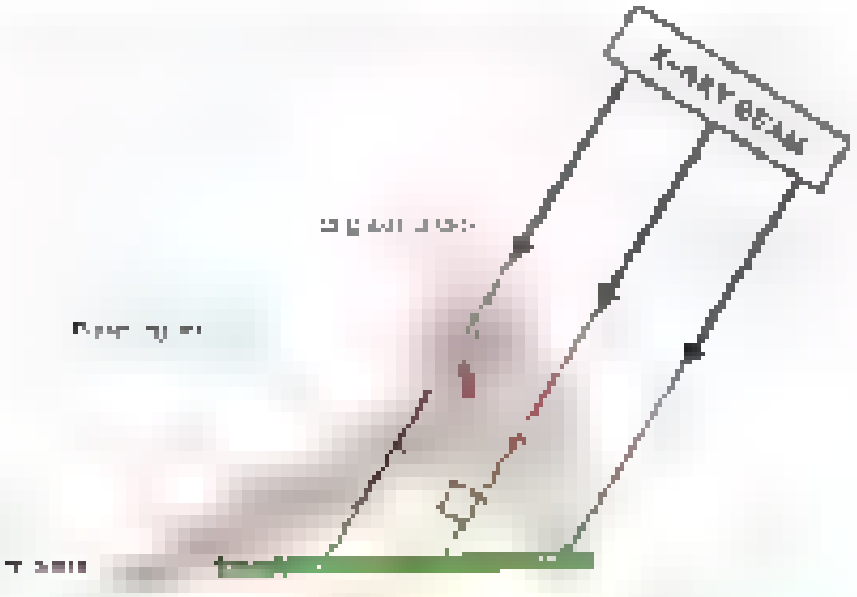


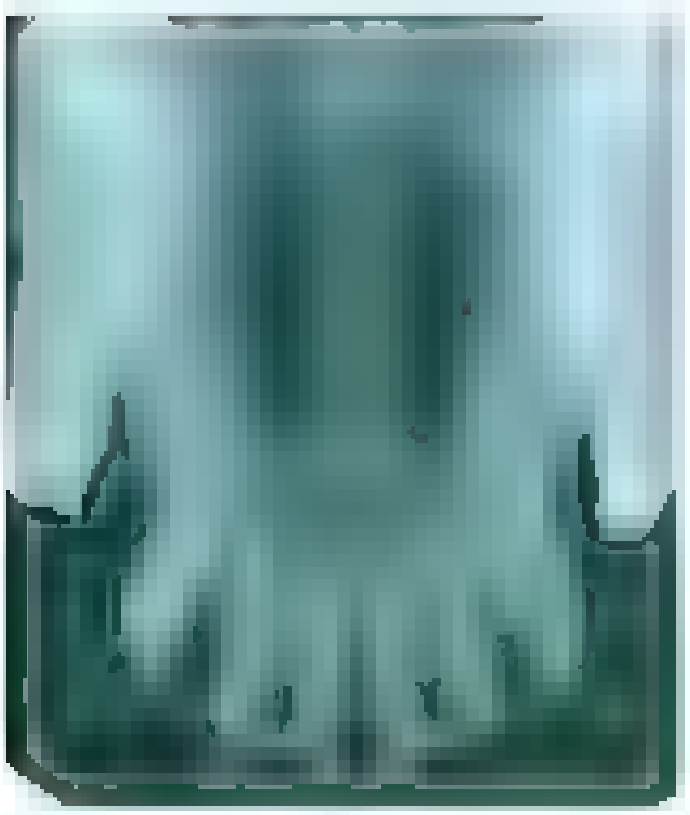
Figure 4.46 Bisecting-line technique. The angle formed by the tooth and film must be bisected. The incident beam is directed perpendicular to the bisecting line.

Figure 4.47 Bisecting-line technique. The placement for maxillary premolar and molars.

Figure 4.42 Shielding the testicles with film placement for mandibular molar and bitewing views

Figure 4.43 Shielding the lower spine with film and T-shaped placement for radiography of the mandibular molars

proper alignment of the vertical and horizontal angulations, the image will be elongated. Elongation usually results when the apex of the tooth is not centered on the film, the image will be shortened or foreshortened if the vertical angulation is too great, or the film is not parallel to the tooth. Radiographs should be taken to reveal the whole tooth.



Superimposition of structures

By changing the angle of the conical beam, superimposed structures (Figure 4.4) can be separated. The SLOOB (same tongue, opposite buccal) rule is applied to superimposed structures and states the direction in which the

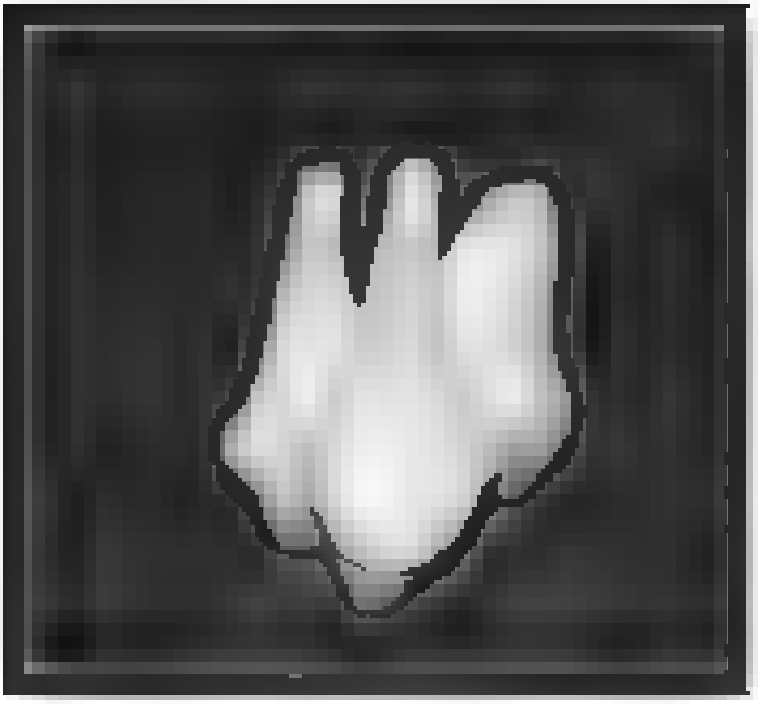


Figure 4.46 By moving the incident beam to a more caudal position on the patella, structures moved to a more caudal position

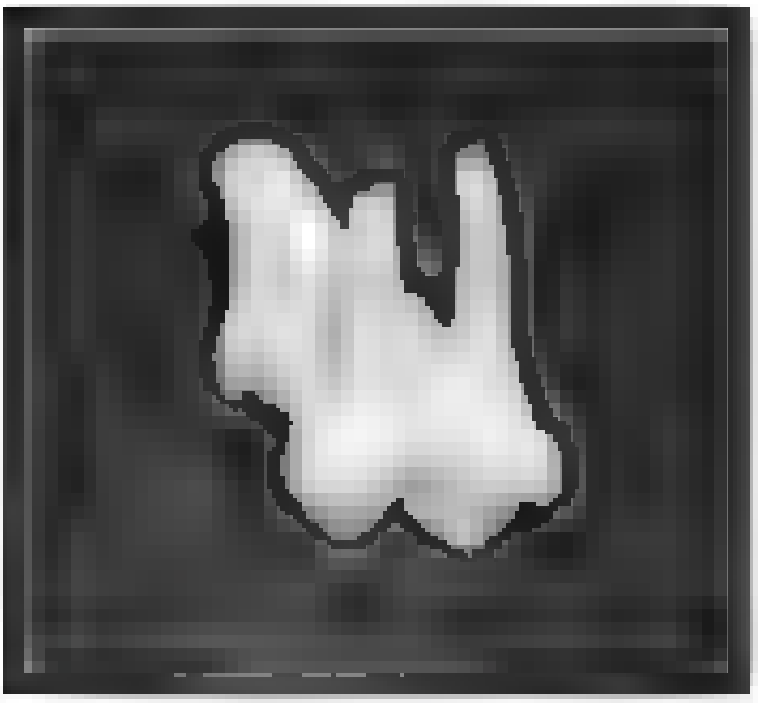


Figure 4.47 By moving the incident beam caudally, the meniscus did not move to a more caudal position

different structures move in relation to the movement of the incident beam. A structure which moves in the same direction as the incident beam is described as moving in the 'parallel mode'. For example, if measuring the patellar tendon length the incident beam is directed above a more central position the tendon will be the only structure in the new radiograph (Figure 4.46). Conversely, if the beam is directed below a central position the structure which moves in the opposite direction to the beam is the most distal structure (i.e. the tibia on the new radiograph will be the most caudal structure) (Figure 4.47).

Figure 4.48 Tooth surface elongation occurs when the incident beam is travelling to be perpendicular to the tooth axis

Converting elongation into lengthening

An elongated beam (Figure 4.48) results from an incident beam travelling towards a tooth perpendicular to the tooth surface (Figure 4.49a). It is evident that the beam should be angled at an oblique angle to the tooth surface (Figure 4.50).

A cone-beam unit (Figure 4.51) emits a circular beam of incident beam travelling towards a tooth perpendicular to the tooth surface (Figure 4.52a). To correct this, the beam should be incident at an oblique angle to the tooth surface (Figure 4.52b). Knowledge of cone anatomy will aid in positioning of the detector film and direction of the incident beam to produce an accurate diagnostic image of the tooth under examination.

Digital imaging

There are a number of extraoral radiographic machines that use digital sensor imaging systems. These can be extremely direct, where the image is captured by a sensor and sent to the computer via a cable, and indirect, where the image is captured via a photostimulable phosphor plate (PSP) that is then scanned by a laser reader and then digitised. The direct system produces the image on a computer screen (Figure 4.54) within a few seconds (Figure 4.55). This takes the place of the conventional cassette film.

Figure 4.49 The X-ray beam is positioned perpendicular to the lateral neck and centred on the angle of the mandible

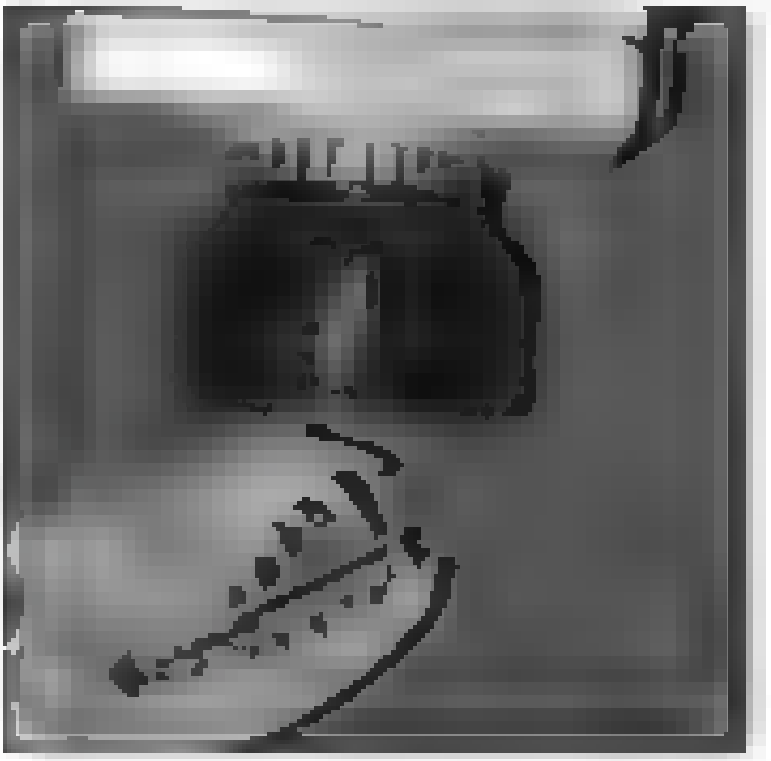


Figure 4.50 Correct placement for radiographing maximum incisors

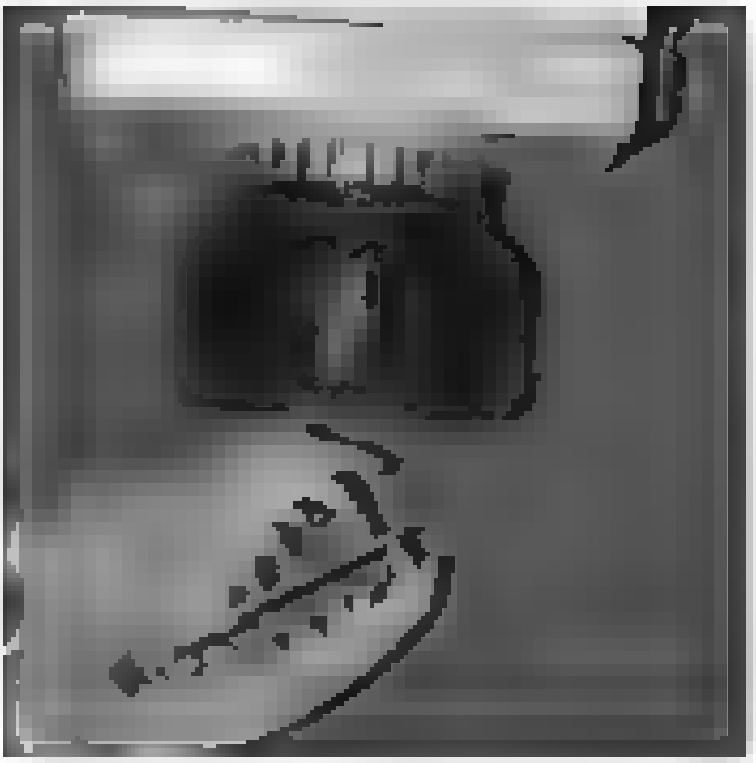


Figure 4.33 Panoramic survey of radiographic misinterpretation

There are a number of advantages to this system including:

- speed – the image is viewed within seconds
- ease – adjustments can be made to the contrast of the stored image to aid interpretation, without damaging the sensitive dye X-ray receptor
- image – can be enhanced and digitally manipulated to aid interpretation.

Disadvantages include:

- cost of the equipment and training
- The ease with which technology can be used to manipulate the image can be misused and it is now possible to alter a radiograph to show pathology that is not present. Similarly, a technician could produce a low exposure image, and by increasing the X-ray generator output, vital pathology could be concealed.

Radiology

Dental radiographs are usually examined using the lingual or buccal view. By convention, maxillary dental radiographs are mounted using the buccal view. This means that the radiographs are mounted with the crowns of teeth or opposing arches facing each other as viewed from the buccal aspect. This means that the patient's right is on the left of the radiograph (Figure 4.34).

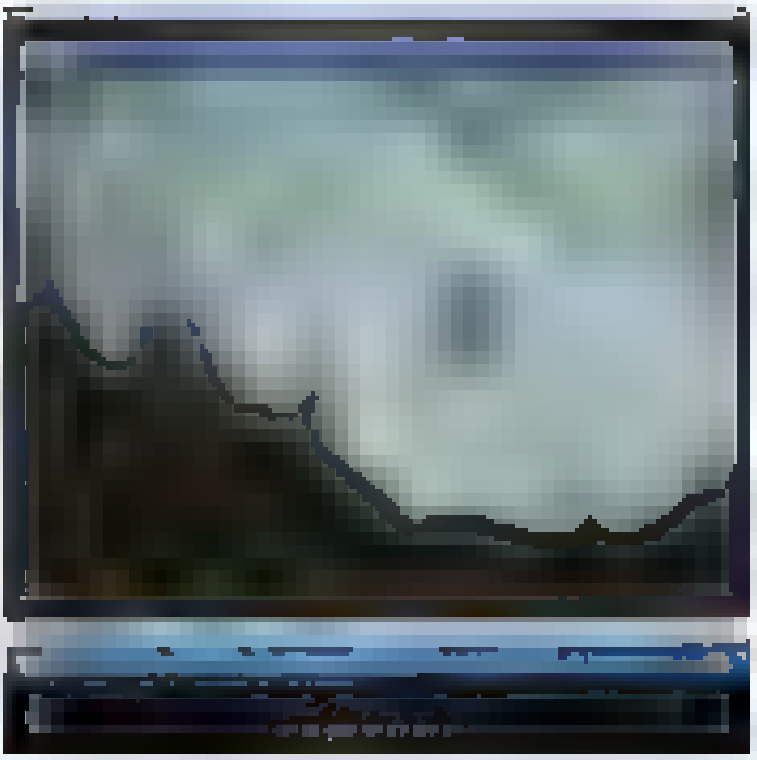


Figure 4.54 Digital X-ray images are transformed in the computer system into [illegible]

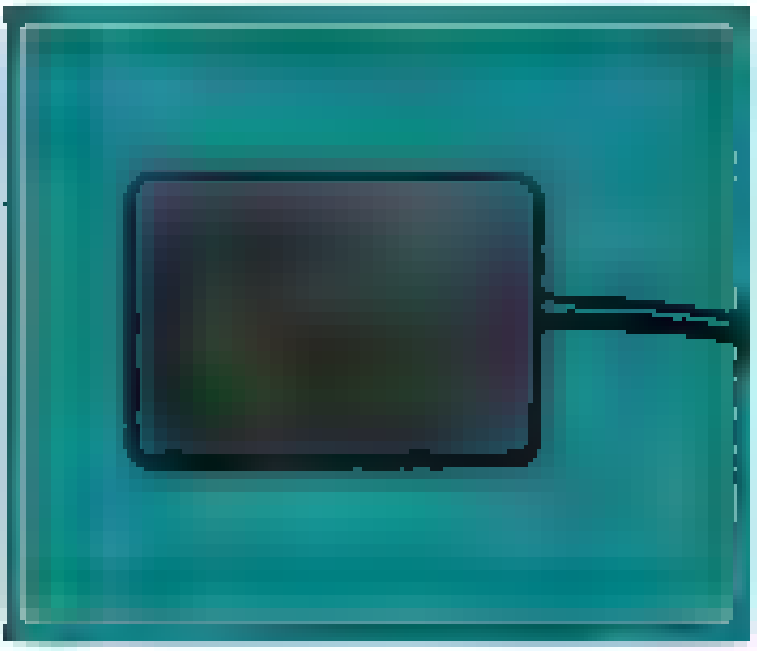
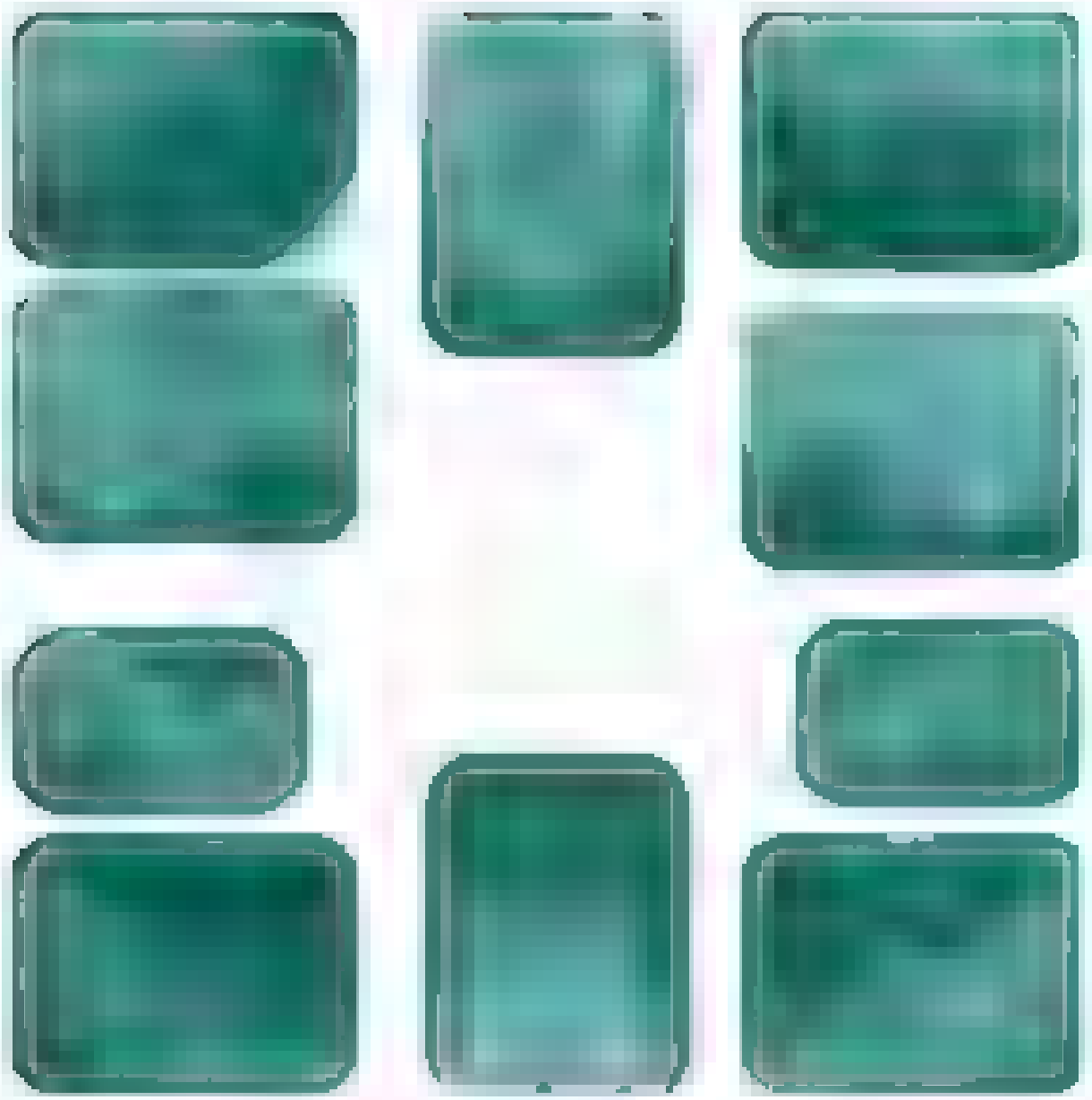


Figure 4.55 A basic digital dental imaging system

Dental radiographic theory examines a dark room, preferably with light passing through the radiograph sheet to peripheral light. Peripheral light causes minor pupillary constriction which decreases diffuse evaluation of the radiograph and the structures radiographed (Figure 4.[illegible]). Magnification and the image is an essential and accurate interpretation (Figure 4.[illegible]).

Systematic examination of the crown, pulp chamber/canals, periodontal ligament space and periapical region is important. The assessment of



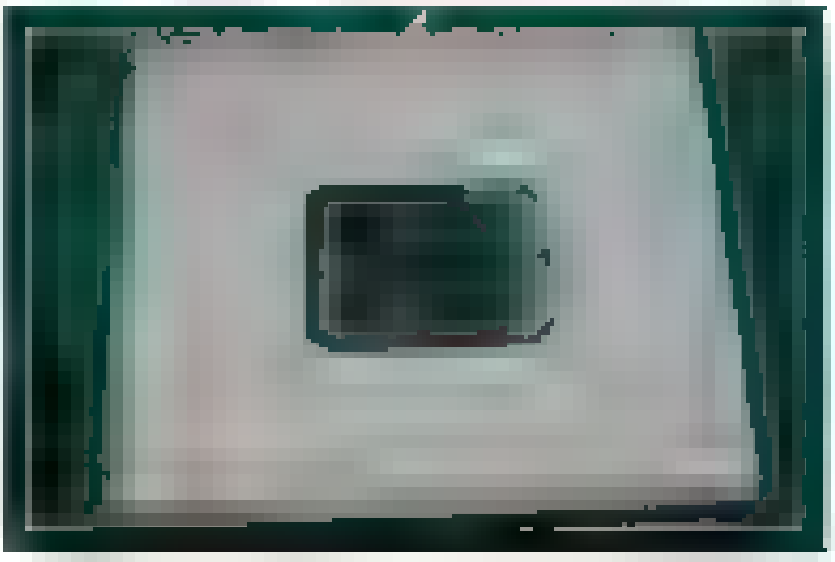


Figure 4.50 Magnified viewing of dental radiographs [illegible]. Interestingly, more detail is visible using magnification.

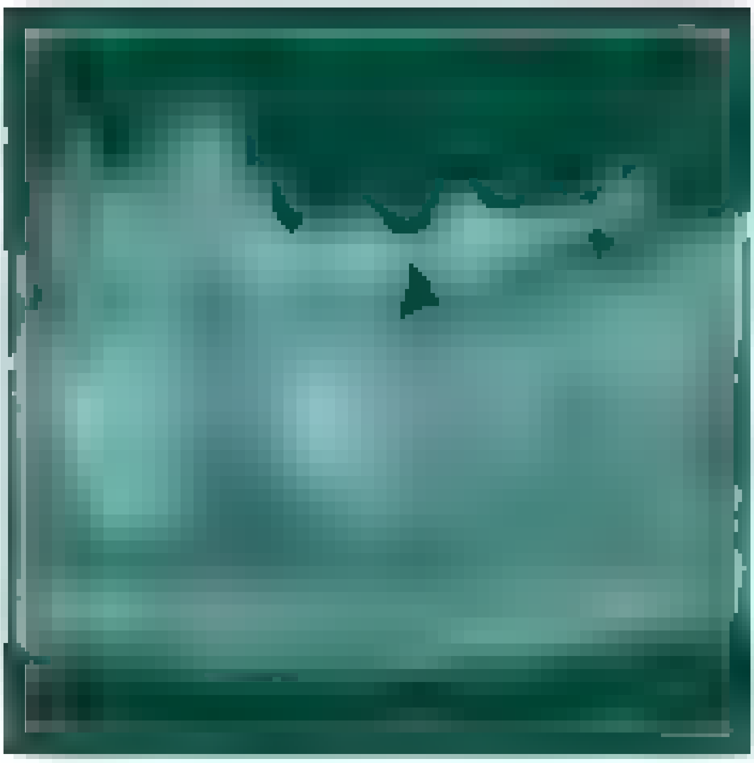


Figure 4.51 [illegible] tooth must be assessed systematically evaluating the crown, roots, periodontal ligament space, lamina dura, the pulp canals and root apex. Periapical tissues must be examined as well.

continuous dura and widening of the periodontal ligament space are indicative of disease and should alert the examiner to investigate further. It may be necessary to take a second or different view of a structure to gain further information (Figure 4.5[illegible]).

Figure 4.58 A right-sided periapical radiograph of the mandibular first premolar and first molar teeth in the distal root area of mandibular left premolar (Figure 4.58).

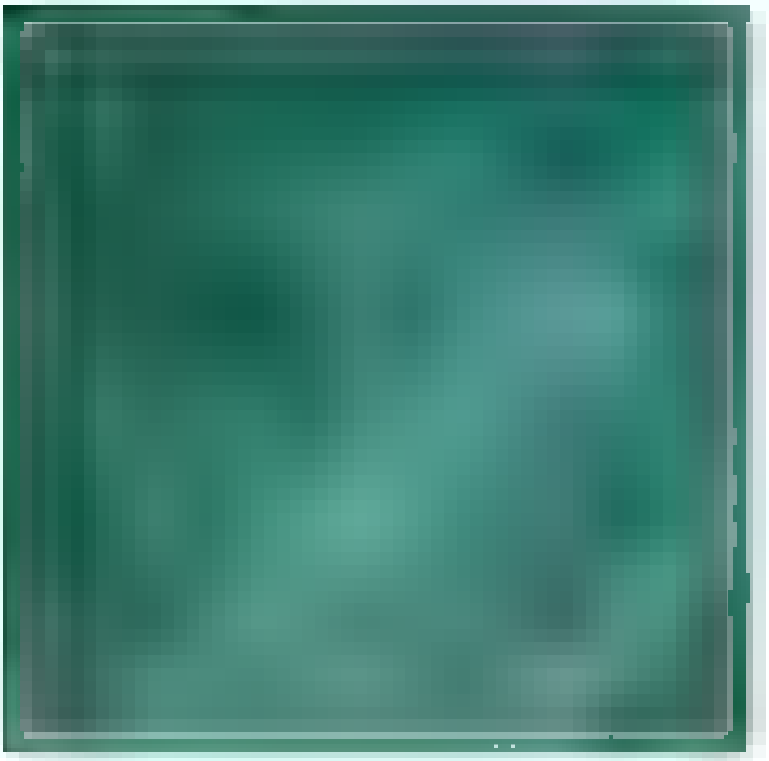


Figure 4.59 This radiograph demonstrates an incidental pathological finding of the mandibular third molar tooth (Figure 4.59).

There are numerous artifacts to consider when viewing radiographs. The mental foramina are commonly seen in the mandibular third and second premolar and sometimes they are misdiagnosed as periapical radiolucency at the mental foramen of the second premolar (Figures 4.60 and 4.61).

Figure 4.43 The intra-oral canine periapical radiograph should include the entire canine tooth and the surrounding bone. There are three root fragments remaining in the dog's mandible after removal of the canine tooth.

The intra-oral technique may create artefacts at the maxillary third of the canine crown (Figure 4.44). The maxillary sinus may also appear as a radiolucency. There is no maxillary recess in the dog or cat.

Normal radiographic anatomy

In young animals the pulp chamber and canal are wide and the root apex is undeveloped (Figure 4.45). The dentine formed in this period is known as primary dentine. As the tooth matures the apex forms and an apical delta develops through which the neurovascular supply (Figure 4.46). The dentine formed after maturity is known as secondary dentine. Primary and secondary dentine are indistinguishable radiographically. Radiographs should be taken of the jaws of young animals where there is suspicion that one or both teeth may be missing. Radiographs are completed at about three to four months of age and the permanent teeth should be visible radiographically in the mandible. Remember that the molars and first premolars do not have deciduous predecessors.

Immature teeth have a wide pulp chamber and relatively narrow tubular dentine. Dentine is a thin layer in humans. Mature teeth have pulp chambers and canals of variable width and dentinal walls of variable thickness depending upon the animal's age and its dental detail. The periodontal ligament space is visible and defined by the lamina dura on the mesial and distal aspects of the

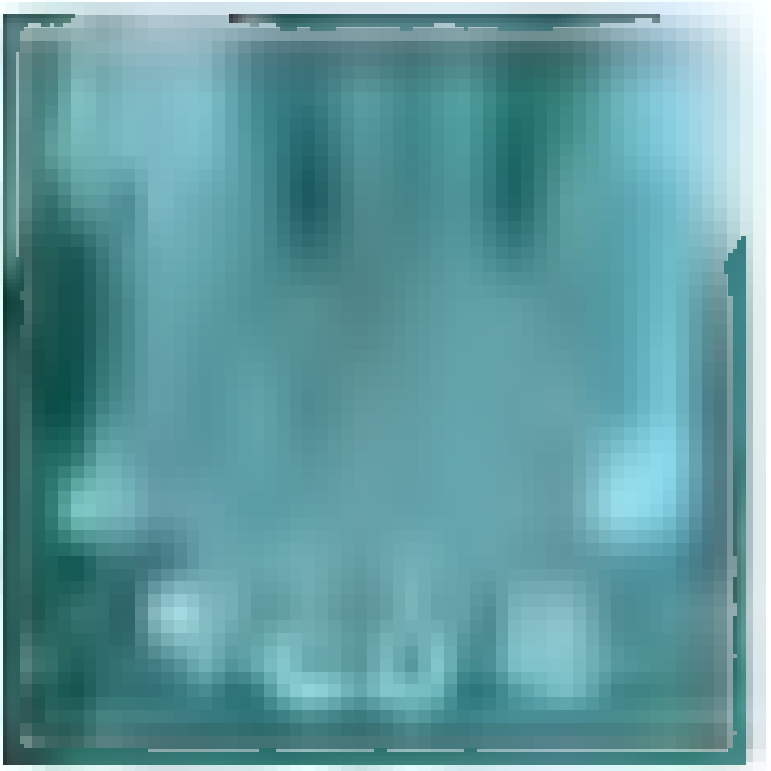


Figure 4.83 Immature teeth have open pulps

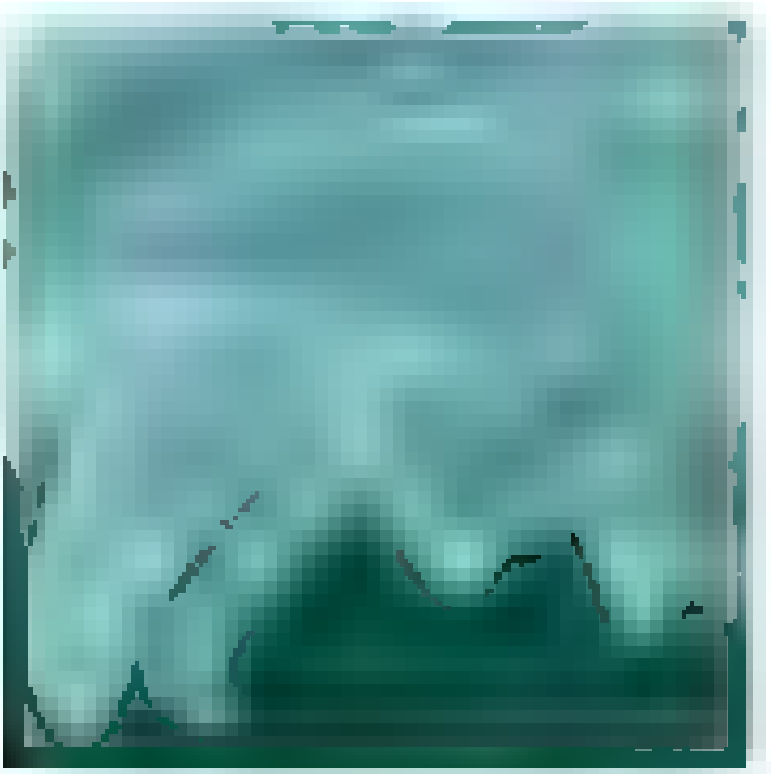


Figure 4.84 As pulp chamber of immature teeth are also predictable with their periapical radiographs

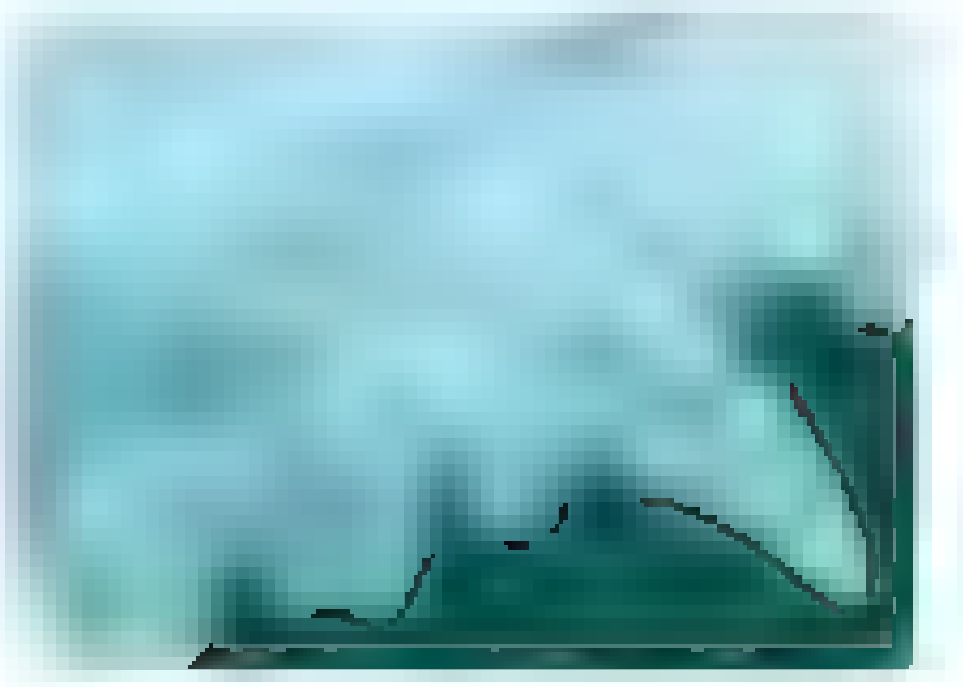


Figure 4.65 Once the apex has formed the wall is considered to be mature. Normal dentin tubules begin to deposit.

the root to the other. The cementum is the connective tissue that covers the root and anchors the periodontal ligament fibers to the tooth. The periodontal space between the root and the alveolar bone is filled with periodontal ligament fibers and blood vessels.

Figure 4.66 The cementum is formed by cementoblasts laying down layers of cementum around the root.

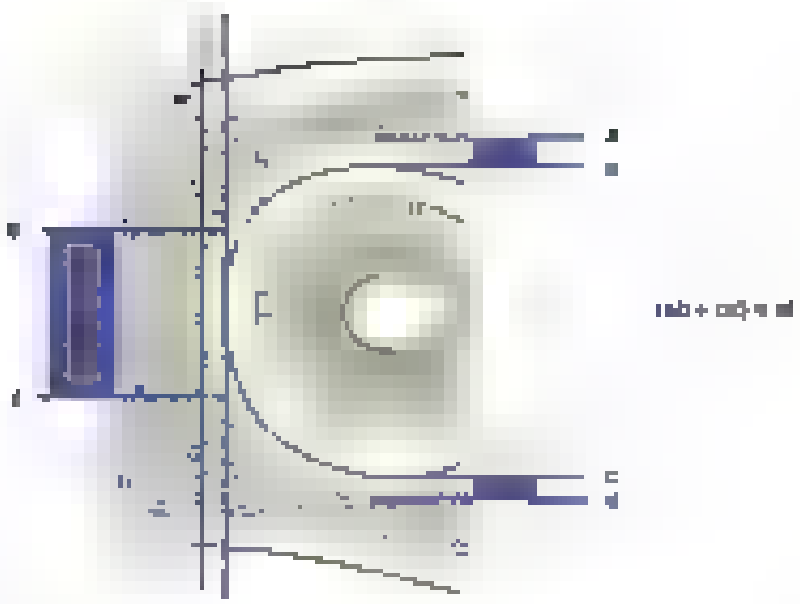


Figure 4.67 This ameloblastoma appears multilocular with thin trabeculae separating the lesion. Some of the trabeculae appear thicker than others.

lower is surrounded with arrows. The ameloblastoma is multilocular and has a "soap bubble" appearance. The cortical bone is slightly enlarged and some cortical bone is absent. Arrows point to mandibular foramen. It is important to remember that all radiographic images are two-dimensional representations of a three-dimensional structure.

Under normal circumstances, the periodontal ligament and cementum prevent external bone resorption by allowing the dentition to function normally. The periodontal space is wider than it would be if the tooth were not functioning. The bone substance becomes osteoporotic with the normal alveolar bone and the teeth are maintained in their bone. Resorption of the cementum of the periodontal ligament can also lead to resorption of the tooth or the alveolar bone. Normal bone turnover causes the periodontal ligament space.

The apical root of the mandibular anterior and the distal root of the mandibular premolars with their have a specific appearance radiographically at these distal and apical aspects corresponding to the developmental groove on the surface of their roots (Figures 4.69 and 4.69).

Common abnormalities encountered

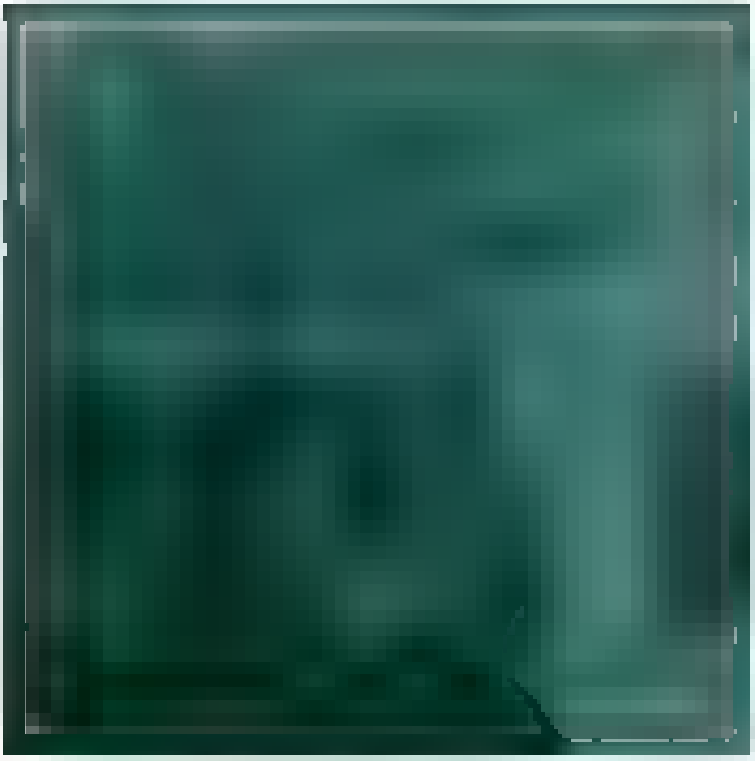
Periapical pathology is caused by bacterial infection and necrosis of the pulp. The spread of an infected pulp usually around the apical foramen (Figures 4.70 and 4.71). The bacteria invade the pulp and cause pulpitis. Radiographic appearance of periapical pathology and other features of inflammation are dependent on the stage of the disease and the host response. During the pulp necrosis as a result of trauma or bacterial infection will also cause periapical pathology.

Widening of the periodontal space and resorption of the lamina dura are indicative of periodontal pathology. In some animals with periodontal disease, pockets may become so extensive that the pulp becomes affected either via lateral or accessory canals or via the apical delta. Furcation areas are also affected by periodontal disease. These areas are associated with deep vertical periodontal pockets. Commonly radiolucent

tomasomes, endosomes. Lysosomes are a result of fully acidosomes containing enzymes that digest materials which enclose extracellular fluid in the endosomal space to form endosomes. These lysosomes are usually associated with degradation of endosomal products.

…operculum…

…Fused …



Obscured radiopaque bear…ion on connecting stem on radiograph and exploration at dentoscope can be challenging. Figures 4… and 4…

Dentoscope with air-water attached by inspection (physical examination purposes) can often seen on radiographs when clinically demolished… examination of… (see figures 4… and 4…).

Figure 4.72 The maxillary left premolar… has a supernumerary tooth which has… with palatal cusp suggesting its presence. The… type… on the radiograph

Figure 4.73 The extracted tooth is Figure … The photograph superior… This tooth was sectioned and palatal… was required… tissue is undamaged

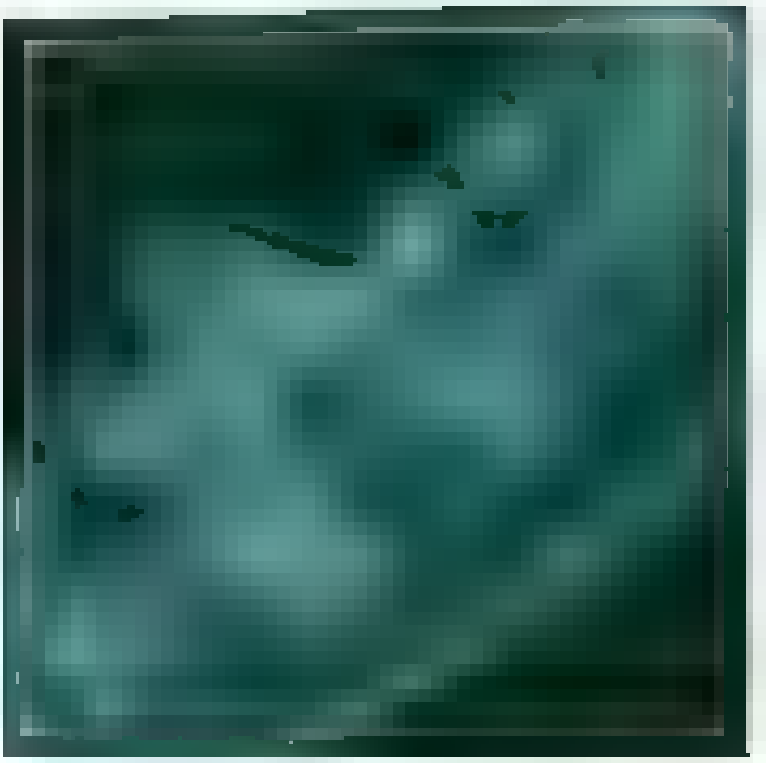


Figure 4.74 [illegible] mouse [illegible] result making [illegible] extraction the technique [illegible] the tooth were [illegible] extracted. Sectioning [illegible] [illegible] fracture and [illegible] root remnants [illegible] the root topography [illegible]

Figure 4.75 [illegible] tooth with angled displacive [illegible] extraction. [illegible]

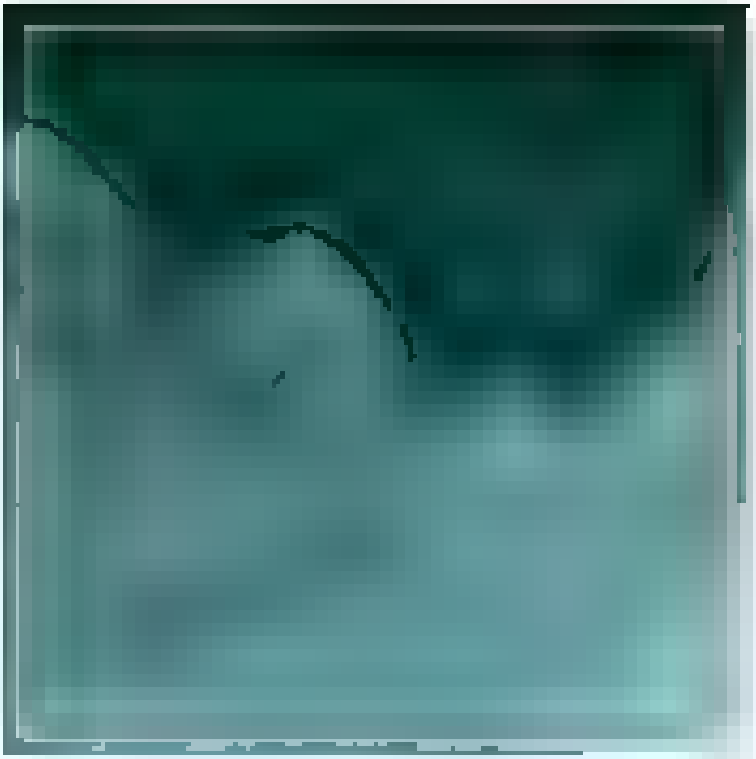


Figure 4-76 The mandibular right premolar–molar periapical radiograph of a patient with a localized periapical radiolucency associated with the root apex of the first molar. Note the widened periodontal ligament space around the root apex.

Some artifacts seen on radiographs (Figures 4-77 to 4-81)

Artifact: Bent film

Cause: Improper placement of film in mouth

Film damage due to placement or biting pressure

Film packet not placed in mouth with the black (lead backing) side toward the tube

Light radiographic image

Film packet placed in mouth with the white (nonlead) side toward the tube during exposure

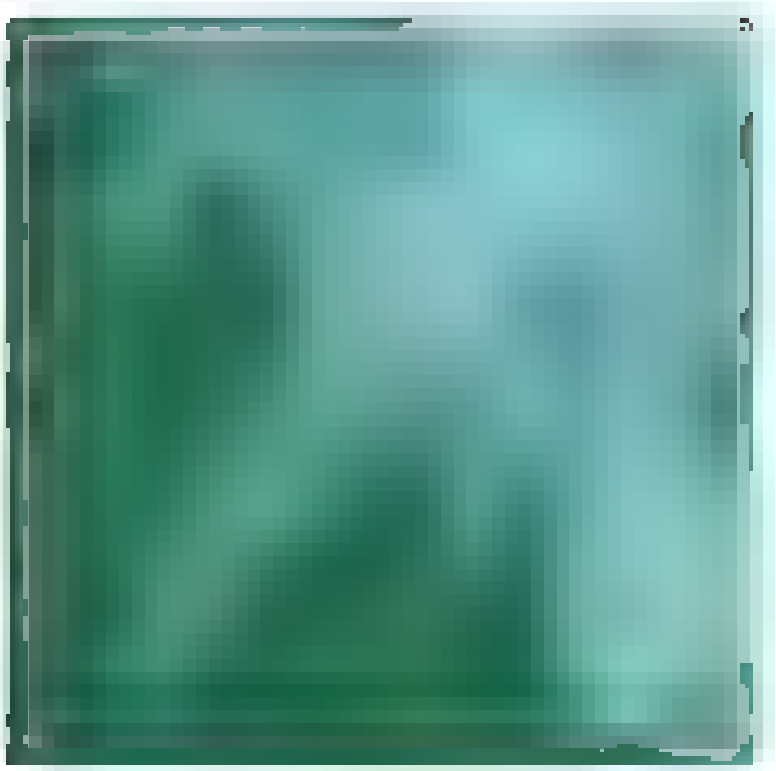
Dark radiographic image

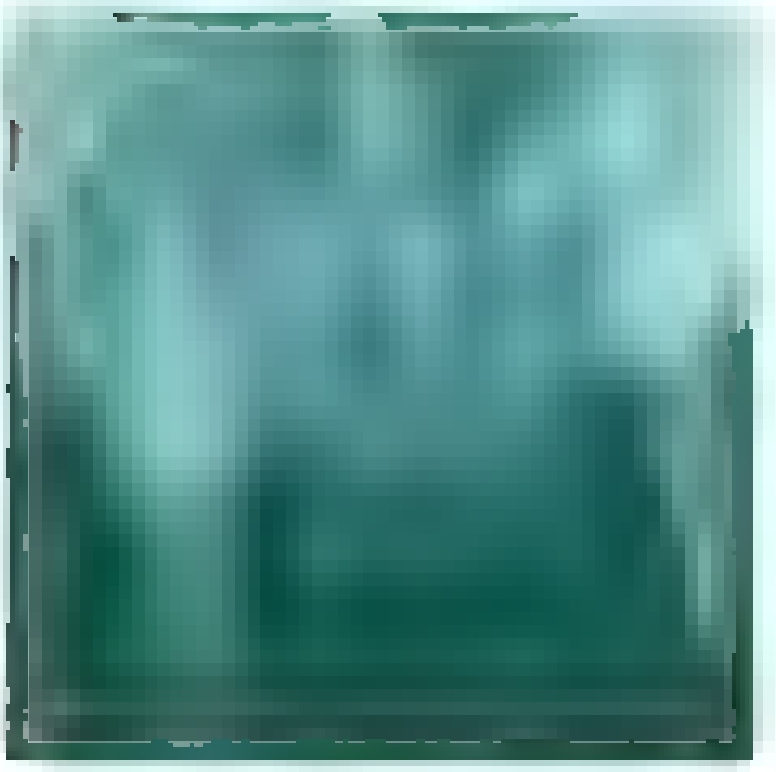
Film packet not placed in mouth with the white (nonlead) side toward the tube during exposure

Film damage due to moisture

Radiograph storage

Radiographs must be stored in such a way that they can be retrieved easily for future examination and comparison. They should be in a cool and dark dry place and the radiographs should be stored and stored thoroughly. Each radiograph must be part of the patient record and must therefore be labeled accordingly with the patient's name and the date of exposure. In addition, space for the radiographs to be stored properly and their details. When using intraoral X-ray films it is important to store them in a way that they do not get damaged during radiographic examination. Intraoral films have a tendency to get damaged during storage.





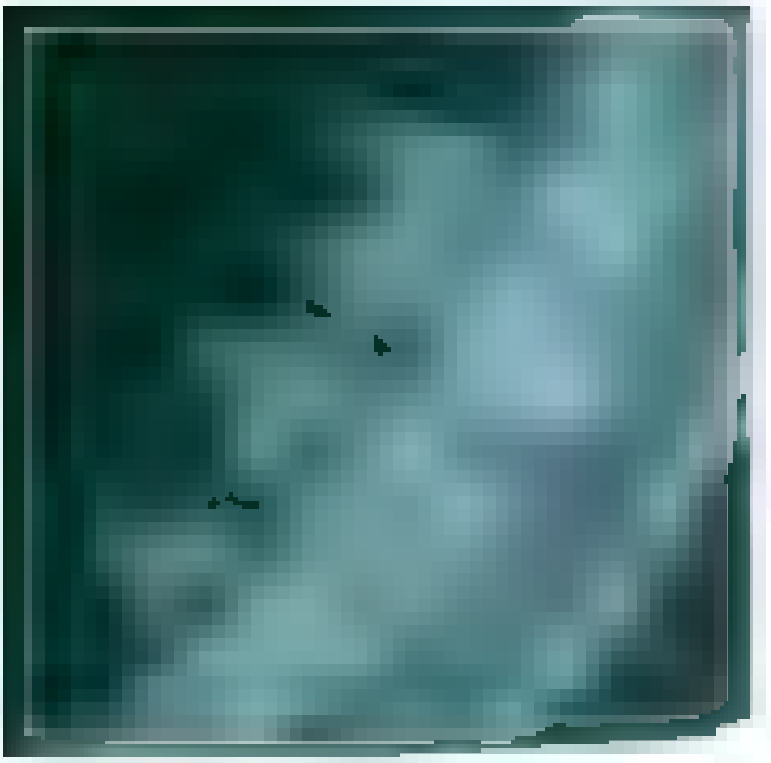


Figure 4.10 Processing chemicals must be discarded into appropriate containers.

Processing chemicals

Processing chemicals may pose a health hazard and must be handled using appropriate protective equipment. Such chemicals must be disposed of according to health and safety regulations and must under no circumstances be poured down the drain.

Further reading

Crooke, P. S. and Berman, L. (Eds) (1999) Advanced Small Animal Dental Imaging. ISAVC Publications, Champaign, IL.

Thrall, D. E. (2002) Textbook of Veterinary Diagnostic Radiology, 4th edn. W. B. Saunders Company, Philadelphia.

Hudson, T. W., Allen, M. F. and Williams, C. A. (1988) Atlas of Intra-oral Dental Radiographic Procedures, 2nd edn. Charles C. Thomas, Springfield.

Wiggs, R. B. and Lobprise, H. B. (1997) Veterinary Dentistry: Principles and Practice, 1st edn. Lippincott-Raven, Philadelphia.

[illegible]oth extraction is final. In selected cases teeth can be replaced using implants; however, [illegible]

Adequate analgesia must be given to patients about to undergo tooth extraction (see Chapter [illegible] Pain Management).

Indications for tooth extraction

- Fractured teeth which cannot be restored
- Teeth affected by caries [illegible] where restoration is not possible
- Persistent deciduous teeth
- Supernumerary teeth causing crowding
- Malocclusion teeth
- Teeth [illegible] fractures [illegible] not providing function/stability
- Periodontally compromised teeth
- Teeth with severe gingival recession
- Malaligned teeth causing gingival and periodontal disease
- Impacted or unerupted teeth (including [illegible] teeth) not amenable to treatment
- Retained deciduous teeth
- Teeth affected by odontoclastic resorption

Figure [illegible]

Figure 5.[illegible] This patient was kicked in the mouth by a horse and suffered multiple fractures of the teeth.

Figure [illegible] [illegible] damaged and the [illegible] missing in this patient. There may be [illegible] trauma [illegible] before the [illegible] defects on the canine.

Figure [illegible] [illegible] canine and the premolars are fractured with chronic pulp exposure. Extraction and root canal therapy is [illegible] indicated in these teeth when the fractures extend subgingivally.

Figure 5.4 [illegible]

Figure 5.5 [illegible]

Figure 5.6 [illegible] are revealed on this periapical radiograph of a permanent mandibular left first molar and second premolar. Radiographs should be performed prior to extraction to determine the proximity of the developing teeth to the extracted deciduous teeth and to confirm that the root is still present.

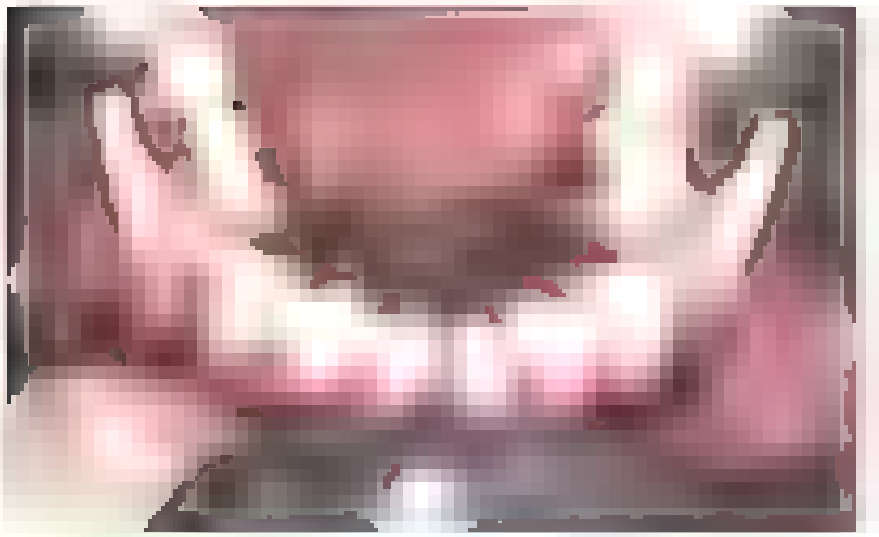


Figure 5.7 [illegible] deciduous canine should be examined to locate the space into which the permanent canine will move. Failing to do this will result in the permanent canine developing in an abnormal position.

Figure 6.8 ...e pulp cavity ... the maxillary left and right lateral incisor are exposed as a result of trauma and decay

Figure 6.9 The maxillary right lateral incisor has undergone fracture of the mesial incisal angle and the mandibular right central and lateral incisors have undergone ... fracture. Observe the dull white appearance of a foreign object within ... pulp chamber. Pulp death or tooth necrosis.

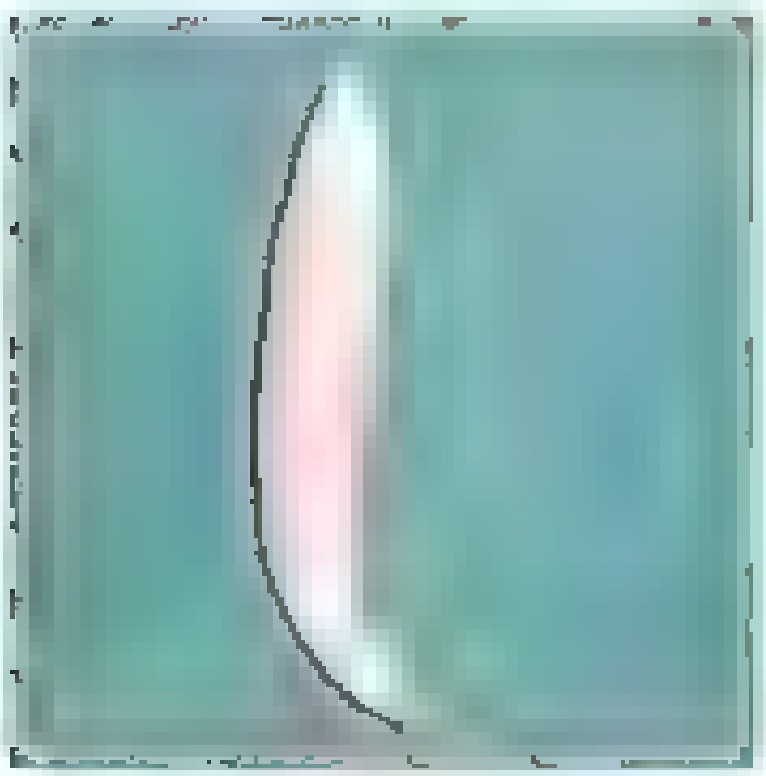


Figure 5-4 [illegible]

Figure 5-5 [illegible]

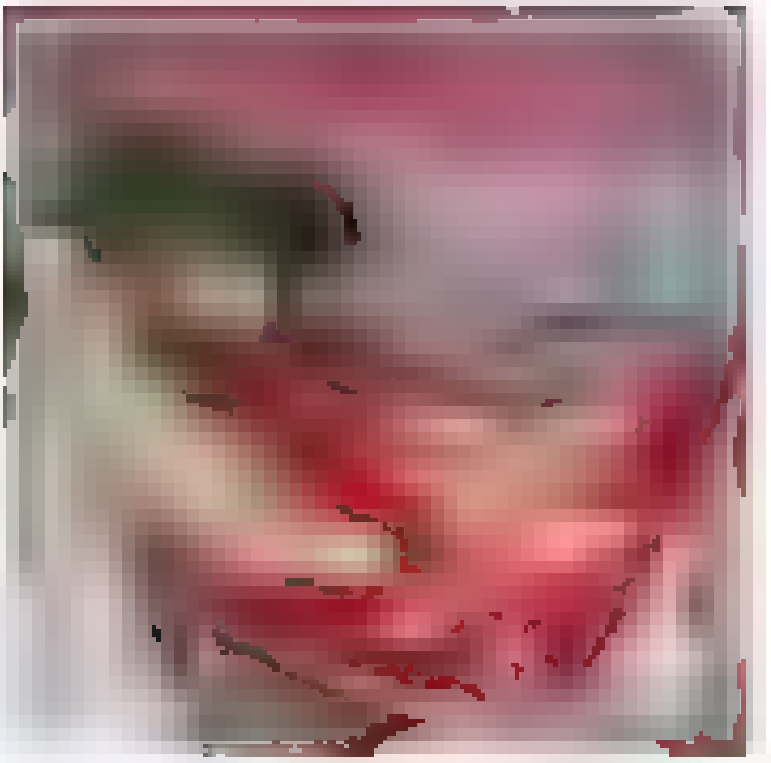


Figure 5.20 A superficial mandibular fracture that led to crowding and compromised jaw function. The affected tooth should be extracted.

Figure 5.21 Deep pockets between teeth are an indication of severe bone loss. Deep scalings and flap surgery are attempts at gingival regeneration, may be undertaken but there is a chance of tooth extraction. Note the mucosal recession between the gowed fingers and a small amount of plaque at the periodontal tissues.

Figure 5.22 [illegible]

Equipment required

[illegible]

Planning

[illegible]

Figure 5.23 A surgical extraction on [illegible] using a periosteal elevator. Adjacent tissue is kept [illegible] with a tissue forceps while the surgical site is [illegible] with a needle holder.

Figure 5.24 An envelope flap raised to perform minor surgical extraction techniques and is held aside by a DAL periosteal elevator. Two molar roots, the roots of which have undergone replacement resorption.

Figure 5.33 A dehiscence with associated soft tissue recession around a mandibular left premolar tooth.

replacement bone to 2 mm below the alveolar margin and tension free closure is the key. Note that any remaining pocket epithelium should be curetted and the soft tissue margin must be extended.

Areas with new superficial bone formation that was created by periosteal undergrafted bone graft will not be exposed. This can result in development of a new alveolar undergraft should also be taken advantage of to rule out the presence of root fragments and retained root fragments but a especially important in those dogs which appear to be receiving premolar or molar quadrant. These teeth are often associated with dehiscence sites which require surgical exposure and extraction of the tooth (Figure 5.34). Failure to extract the root and retained tooth may result in breakage of the elevated mandible. The tooth and associated tissues must be submitted for histopathological examination to rule out neoplasia.

Important structures and areas susceptible to damage must be considered when planning extraction and surgical flaps (Figure 5.35).

Teeth may be extracted by one of two techniques, the simple closed extraction technique or surgical open extraction technique.

Generally working single-rooted teeth and those multi-rooted teeth which are widely periodontally compromised may be extracted using the simple extraction technique.

The simple (closed) extraction technique

In this technique the tooth is extracted without a surgical flap being raised to expose the [illegible] bone over the gingival attachment by placing

[illegible]

[illegible] the gingival sulcus [illegible] and [illegible] the attachment down to the alveolar crest circumferentially around the neck of the tooth. A sharp luxation instrument can also be used to sever the epithelial attachment (Figures 5-[illegible] and [illegible]).

Dental luxation instruments and elevators must be held in such a way that they will not cause damage to soft tissues and adjacent vital organs [illegible] neurovascular bundles and the brain) should they slip. The instrument is held in the palm of the hand (Figure [illegible]) with the index finger extended along the shaft of the instrument (Figure [illegible] and Figure [illegible]). Once the epithelial attachment has been [illegible], a dental luxator® is inserted into the sulcus and gently worked apically into the periodontal ligament space (Figures [illegible] and [illegible]). The fine tip of the luxator® will [illegible] the ligament and compress the alveolar bone, creating space for the more robust elevator to be inserted. Begin by working on the lingual aspect of teeth and then progress buccally (Figures [illegible]). [illegible] gentle rotational wrist movements about the shaft of the luxator® will aid in destruction of the periodontal ligament in an apical direction. It is often possible to deliver the tooth from its alveolus using a luxator® (Figure [illegible]). Once the tooth has become loosened and the periodontal space enlarged, an elevator can be used to further loosen the tooth and deliver it from the alveolus.

Luxation instruments and elevators should never be used as levers in a manner resembling the opening of a paint can using a screwdriver (Figure [illegible] A). Leverage actions applied to elevators are rotational about the shaft of the instrument (Figure [illegible]).

When sufficiently loosened, the tooth can either be delivered using an elevator or gently lifted out using dental extraction forceps. A word of advice: [illegible] dental extraction forceps until you have [illegible]

Figure 5.2 – Reversing the perpendicular trajectory vertically through a mirror

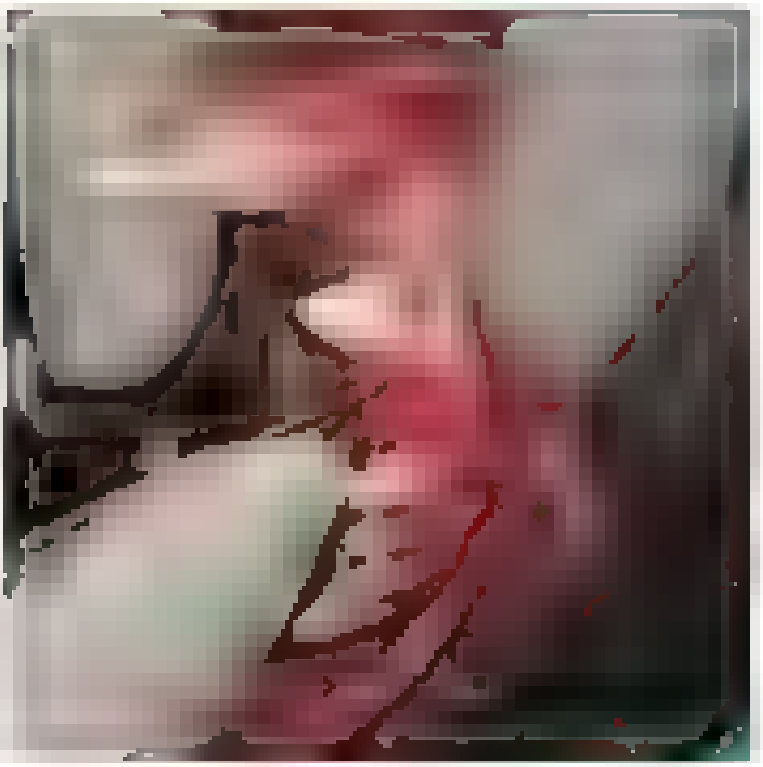


Figure 5.3 – Reversing the perpendicular trajectory vertically using a parabolic

use fragmentation where dorsal transection nerves will lead to [illegible] and uncoated ends of [illegible] as well as prolonging the procedure by having a reserve nerve [illegible]. There are numerous patterns of dorsal transection [illegible] designed for consistent [illegible] distances shaped [illegible]

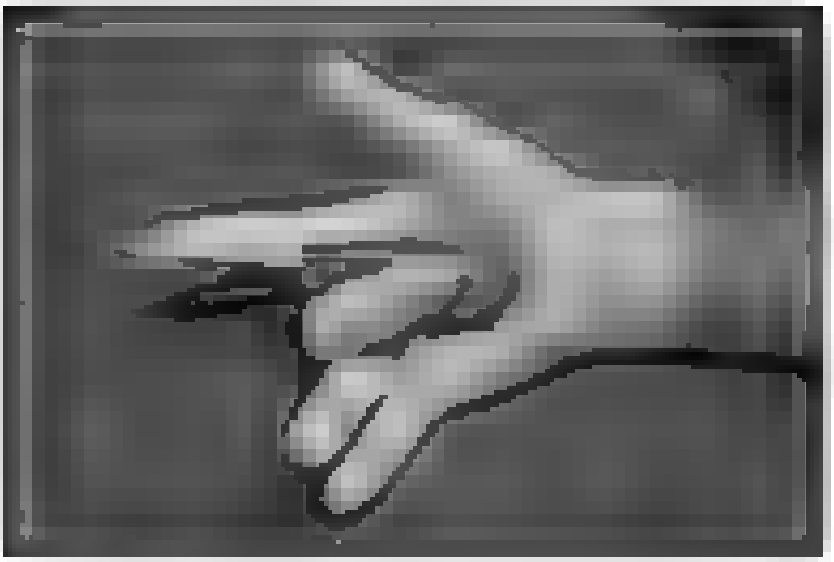


Figure 5.29 [illegible]

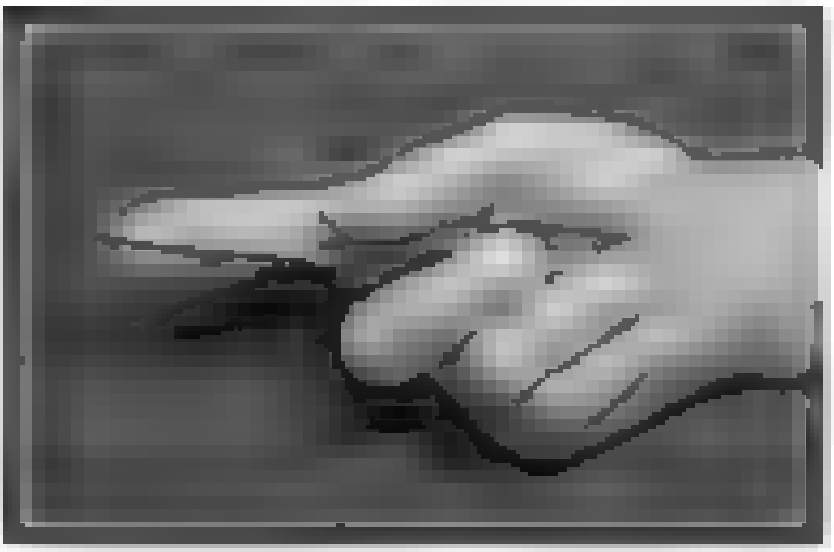
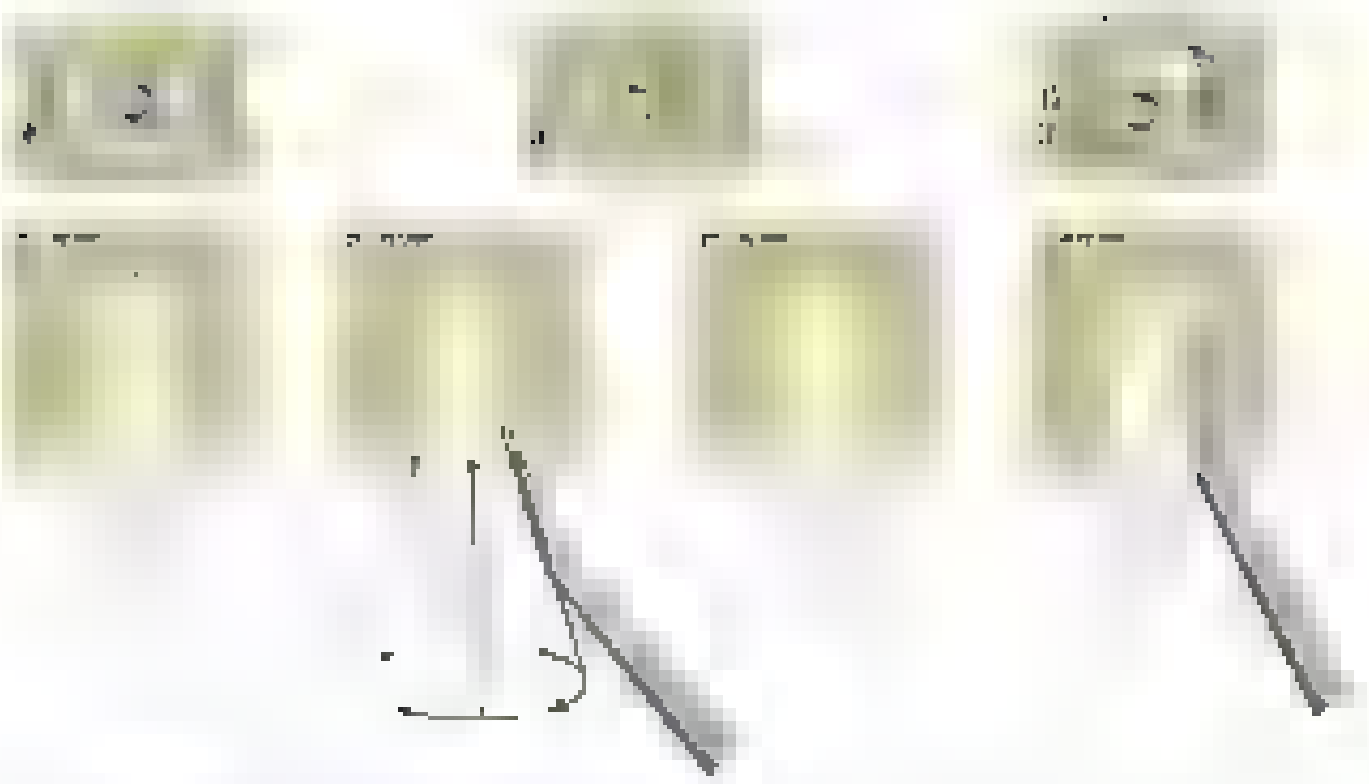


Figure 5.30 [illegible]

Figure 5.31 [illegible]



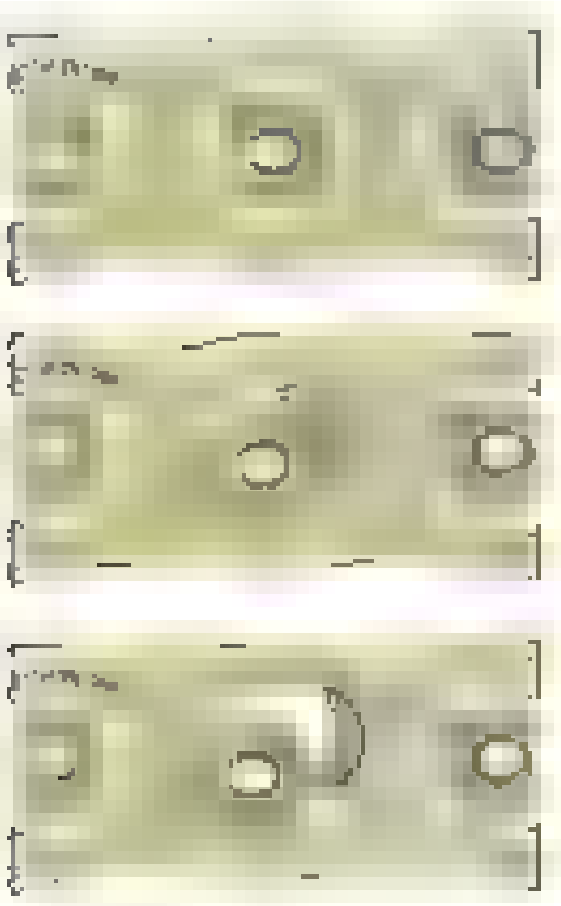


Figure 5.38 Using a scratch* to discover the [illegible]

Figure 5.39 Using the [illegible] and [illegible] to discover the [illegible] from a paint [illegible]

[illegible] and moving it. There are appropriate [illegible] to discover: [illegible]. When discovering the [illegible] from the direction using [illegible], place the [illegible] at the [illegible] and [illegible] the [illegible] using [illegible] that the [illegible] [illegible] through around the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

Figure 5.48 Bleeding should be controlled through the socket

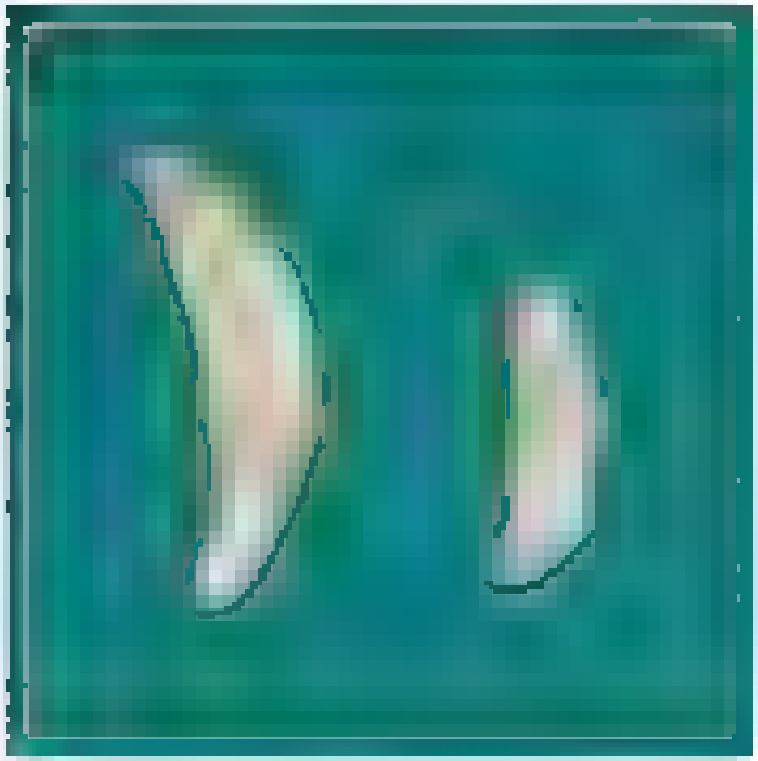


Figure 5.49 Extensive and multiple carious lesions have large, irregular shaped roots which are unsuitable for simple extraction techniques and should be referred for surgical procedures

Following simple extraction the alveolus can be allowed to heal by second intention to an appearing saucer-like defect with gingiva to cover the socket preventing exposure of bone and other debris and promoting firm cicatrised healing. Sutures are rarely used unless the wound is lacerated

The surgical (open) extraction technique

The surgical extraction technique is used for the extraction of multi-rooted teeth as well as for single-rooted teeth which have abnormally shaped or very large roots. The latter include the maxillary canine teeth and the maxillary and mandibular premolars (Figure 5.49).

Extracting single-rooted teeth

When single-rooted teeth are fractured with no gingival connection at the base, but a surgical approach will provide better visualisation and speed up the extraction process. A gingival flap is raised, as described, and the tooth is loosened with Figure 5.50). Either an incision or the flap must allow the flap

Figure 5.42 Stages in raising a mucoperiosteal flap.

A A gingival incision is made with receiving instruments (periosteal elevator and scalpel). The position of the gingival and releasing incisions is planned so as not to compromise the vessels. The releasing incisions are made perpendicular to the gingival incision and extend through to the gingiva.

B A periosteal elevator is used to raise the mucoperiosteum. Care must be taken to avoid damage to the papillae between the teeth.

C Flap is raised to expose the bone. Care must be taken to avoid damage to the nerves and vessels emerging from the mental foramen.

D An alveoloplasty is performed removing bone to expose the cementoenamel junction.

E A surgical curette is used to remove the periodontal ligament and granulation tissue from the socket.

F The flap is sutured back in place using resorbable monofilament absorbable suture material.

Sharp-ended right angle scissors and elevator instruments are used to dissect the tissue from the alveolar bone. The alveolar bone is undercut at its buccal aspect against which rotational forces are applied. Alveoloplasty is performed prior to the flap being sutured to ensure the flap lies flat (removing any sharp alveolar edges).

...close the defect a releasing incision is made in the periosteum at the base of the flap allowing it to be advanced over the defect (Figure 5.43).

Extracting two-rooted teeth

It is often beneficial to section the crown of two-rooted teeth as this facilitates access to the periodontal ligament. This will also prevent fracture

Figure 5.43 Different sections in the flap: a releasing incision is made in the periosteum at the base of the flap allowing advancement of the flap.
A: The gingival margin is moved down to the alveolar margin.
B: The mucoperiosteal flap is moved apically and sutured.
C: A releasing incision is made at the base of the flap parallel to the mucogingival line.
D: The flap is advanced.
E: The flap is advanced and sutured with interrupted sutures. Note that the releasing incision is sutured.

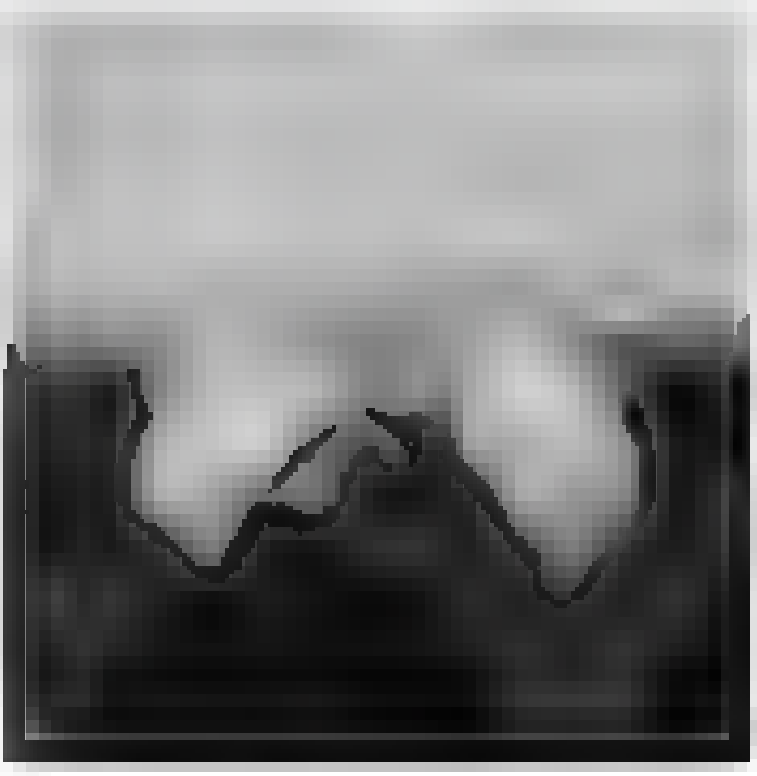


Figure 5.44 A wedge of bone is removed to create better access to the periodontal ligament space.

bur: a undercut coverage against the crown wall: accessing the periodontal ligament. Another beneficial technique is to excise a wedge from the crown. Beginning at the furcation, the crown is sectioned mesio- and distocervically and the wedge of crown is removed (Figure 5.44). This creates coverage against a full crown fragment (Figure 5.45), increasing coverage under which can remain as crown and root fracture. When roots are very close together, both

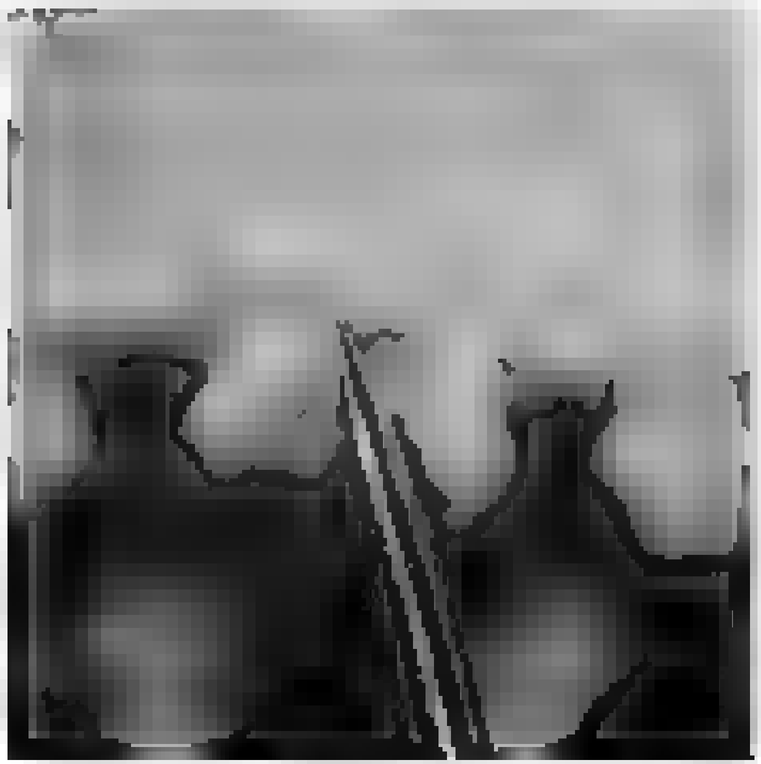


Figure 5.45 [illegible] elevator can be used between the two crown segments although the danger of crown or root fracture as a result of leverage between the crowns.

bulge of the tooth to be extracted [illegible] removed using a high speed bur to create easy and narrow access to the periodontal ligament.

A surgical flap is raised to expose alveolar bone and allow elevators to access the roots of the teeth to be extracted (Figure 5.46). An envelope flap or larger flap can be raised with one or two releasing incisions. In the experience of the author a flap is easily raised by introducing a periosteal elevator under the periosteum at the alveolar margin. Once the alveolar periosteum has been raised, the periosteal elevator should be advanced under the attached gingiva and through the previously severed gingival epithelial attachment. If approached from the attached gingiva side, the periosteal elevator may be inadvertently advanced through the mucogingival junction destroying the flap.

Flaps must have wide bases. [illegible] important structures [illegible] salivary glands and ducts etc.) be protected from the bur and cared in such a manner that they are not under any tension. It is better for flaps not to begin over the furcation of a tooth or in the interdental papilla (Figures 5.4[illegible] and 5.46). Ideally, flaps should begin at the line angle (Figure 5.45) of the adjacent tooth and run perpendicular to the alveolar margin into the corresponding alveolar mucosa making a curved junction with the gingival incision. Having a curved point aids in suturing of the flap and maintains blood supply to the edge of the flap. Line angles are the junction of two perpendicular surfaces of a tooth and are defined as follows: mesio-lingual (palatal), mesio-buccal; disto-buccal and disto-lingual (palatal); disto-occlusal, lingual (palato-occlusal), mesio-occlusal and bucco-occlusal.

The epithelial attachment is severed as described for simple extraction technique (p. [illegible]) and the incision extended rostrally and caudally providing sufficient access to the affected tooth alveolar [illegible] periosteum

Figure 5.44 Wide mucoperiosteal flap access for extraction of a severely resorbed tooth.

A The gingiva is incised by placing a no. 15 blade into the gingival sulcus / pocket and moving down to the alveolar margin. The incision is then continued parallel to the gingival margin and at the mesial angle of the tooth to be extracted. This is the distal cut.

B A single, wide flap is raised to expose the buccal aspect of the roots to be extracted.

C The crown of the tooth to be extracted is sectioned from the furcation through the crown, and a wedge of crown may be removed.

D The mucoperiosteal flap is raised by retaining the periosteal elevator under the periosteum distal to the most distal tooth and advancing it in a coronal direction before progressing coronally and mesially.

The flap is raised and reflected to expose the alveolar bone over the roots.

Alveoloplasty is performed to expose the interdental ligament for a distance of about three quarters of the length of the roots.

E Luxation and extraction of the crown / root segments is performed.

F The flap is closed without tension using white, braided, absorbable suture material. Before closure of the flap, a palatal / lingual releasing incision should be made as described in Figure 5.4.

Tooth to be removed. The incision is raised and then elevated using periosteal elevator to expose alveolar bone. Alveoloplasty is performed after flap closure to prevent damage to the flap from sharp alveolar edges.

releasing incision should be extended through the mucosa to an appropriate level, usually about three quarters of the length of the buccal alveolar bridge exposed. Buccal and lingual cortical alveolar bone should then be removed to expose the furcation. Here much the roots will be

Figure 5.47 An illustration that part of a multi-routine investment may always have the work [redacted] purpose, but the [redacted] will complement the [redacted]

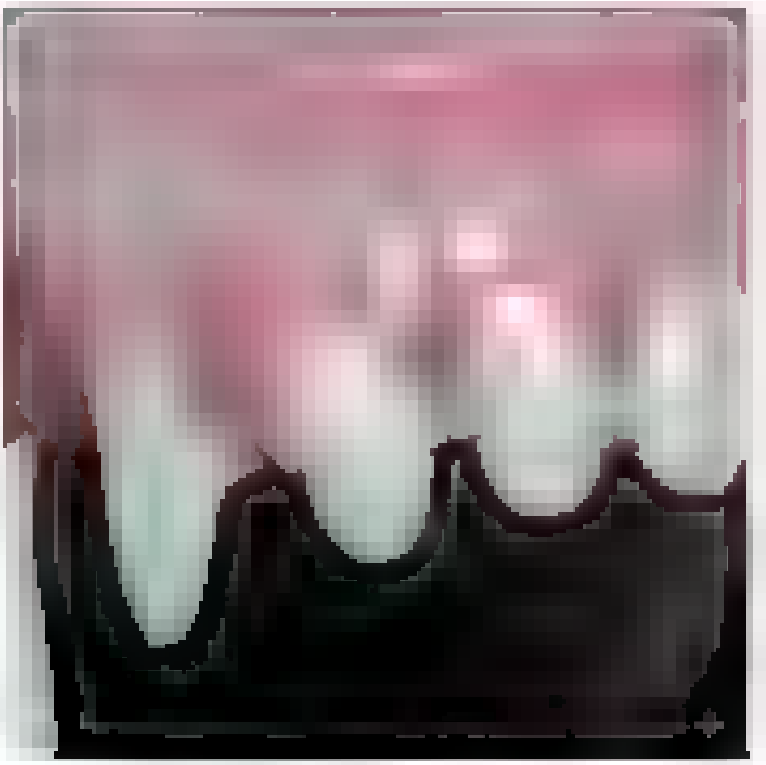


Figure 5.48 The [redacted] that part [redacted] the [redacted] which [redacted] naturally [redacted] adjacent [redacted]

accessed through the [redacted]. Buccal alveolar [redacted] should be removed [redacted] [redacted] about [redacted] quarters of the height of each tooth. Successive bone sheets are removed to create access [redacted] the periodontal ligament. Initially, a curette should be used to reveal the ligament. Covered by coverage assuring

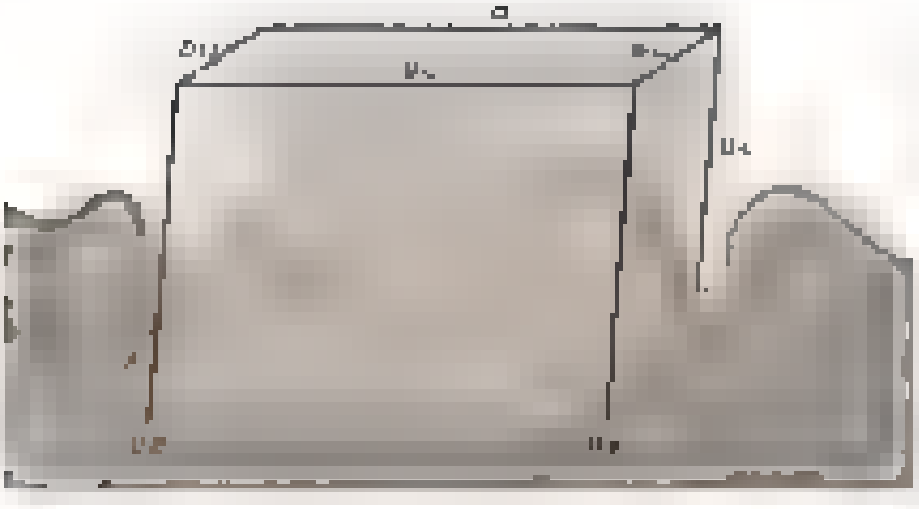


Figure 5.49 An angle on the intersection of [illegible]

Figure 5.50 A shallow dot can be observed with the naked eye [illegible]

[illegible] If the tooth does not receive adequate buccal alveolar bone [illegible] the buccal aspect [illegible] the root surface does not [illegible] A shallow dehiscence [illegible] of the tooth [illegible] a ridge apical [illegible] the dehiscence [illegible] the alveolar margin at [illegible] Figure 10- [illegible] adequately covered, [illegible] can be delivered using [illegible]

When bone loss has occurred alveoloplasty should be performed [illegible] remove any sharp alveolar ridges and reduce alveolar bone using a [illegible] round

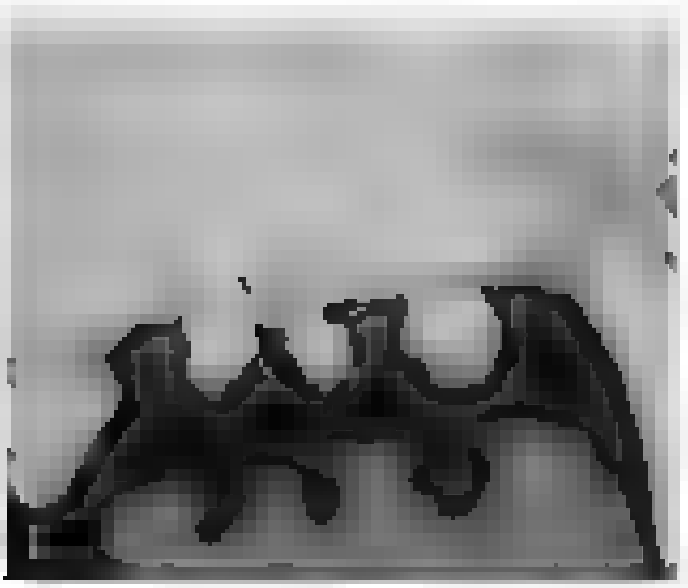


Figure 5.57 [illegible]

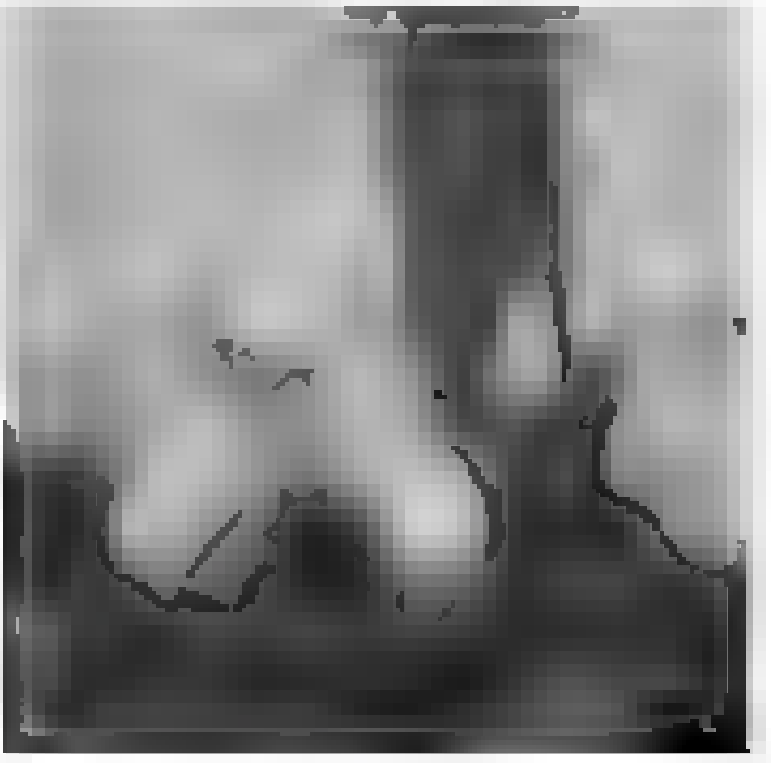


Figure 5.58 [illegible]

[illegible] shown in Figure 5.[illegible]. The clip should be [illegible] without tension. If necessary, remove the film and water tension, a retaining screw should be made through the perforation at the base of the clip [illegible] the counterpoint position: see Figure 5.[illegible]. This will allow the clip to advance unobstructed and enable tension free [illegible]. The pictorial diagram [illegible] gate should be removed from the base by unscrewing the two clip fixings.

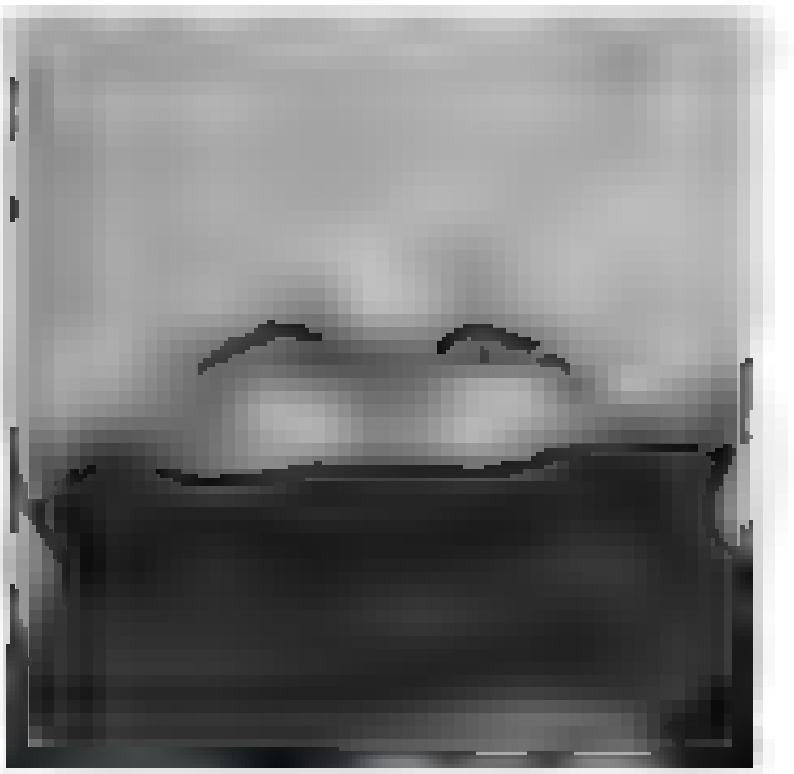


Figure 5.53 Alveoloplasty. If perforation appears to flap closure to prevent damage to the flap, trim bony alveolar ridges

Extracting three-rooted teeth

The maxillary second and third teeth usually have three roots as does the mandibular second tooth. The mandibular third tooth and although the maxillary molars may have two to three roots the buccal roots are usually fused. Care must be exercised when assessing the teeth using the simple extraction technique.

A surgical flap should be raised as described in the section on extraction of two-rooted teeth above. The palatal crown-root segment should be delivered from the tooth socket by luxating the buccal crown-root segments (Figure 5.54 and 5.55). Care must be taken to avoid damage to the palatal root by excessive force which would result in root fracture during extraction. The buccal crown-root segments are then elevated followed by removal of interradicular bone starting apical to the cervical aspect (Figure 5.56). Once the buccal roots have been removed, the crown bone bur is used to remove the palatal root by sectioning across the root (Figure 5.57). It is important to remember to leave the periodontal attachment circumferentially around the palatal root as well because this attachment can be particularly strong around three-rooted teeth. Achieving this often usually requires the presence of the buccal flap to permit cleaning of the interradicular surface.

It is preferable to perform alveoloplasty using a large round diamond bur, as it not only removes the alveolar bone effectively but also tends to cause less trauma to the soft tissues. Adequate irrigation is essential to prevent alveolar bone necrosis from frictional heat.

As much alveolar bone as possible should be maintained to avoid new measurements especially in cases with compromised periodontal tissues.

Figure 5.94 The palatal rugae of the maxillary right lateral incisor being enhanced

Figure 5.95 The palatal rugae of maxillary right lateral incisor being enhanced. The bar should be directed at about 45° between the palatal rugae and incisal edge

When impressions have voids and unwanted materials have been removed, even more of the remaining teeth could be revealed. Consider that some of the teeth may have been in the opposing corner. The mandibular anatomical teeth should now be visible in the patient after the maxillary anatomical teeth (premolar 4) and molar 1 have been removed. This would help ensure adequate space is available for the crown to prevent palatal trauma.

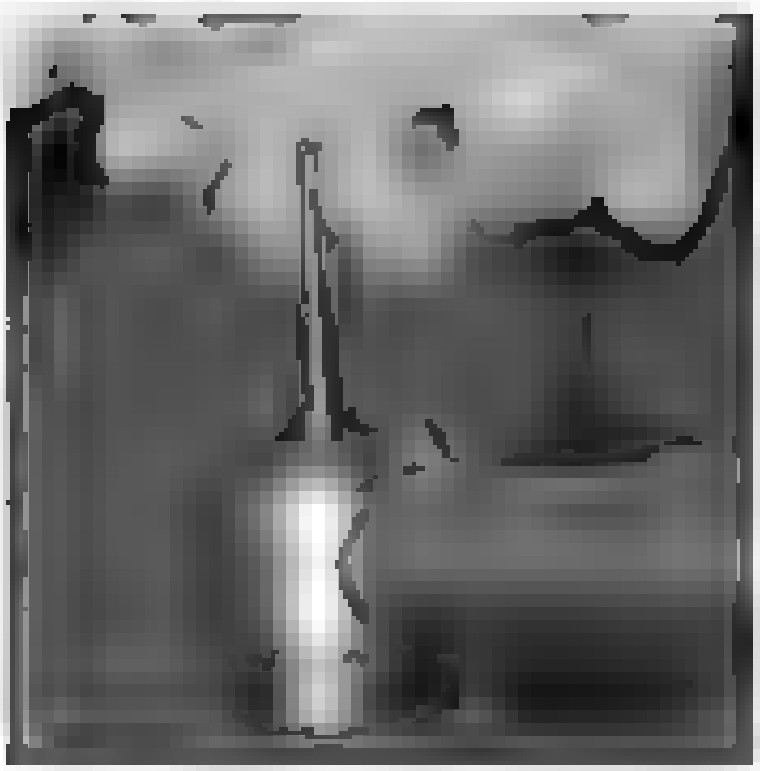


Figure 5-36 The buccal cusps of the maxillary right molars are being reduced.

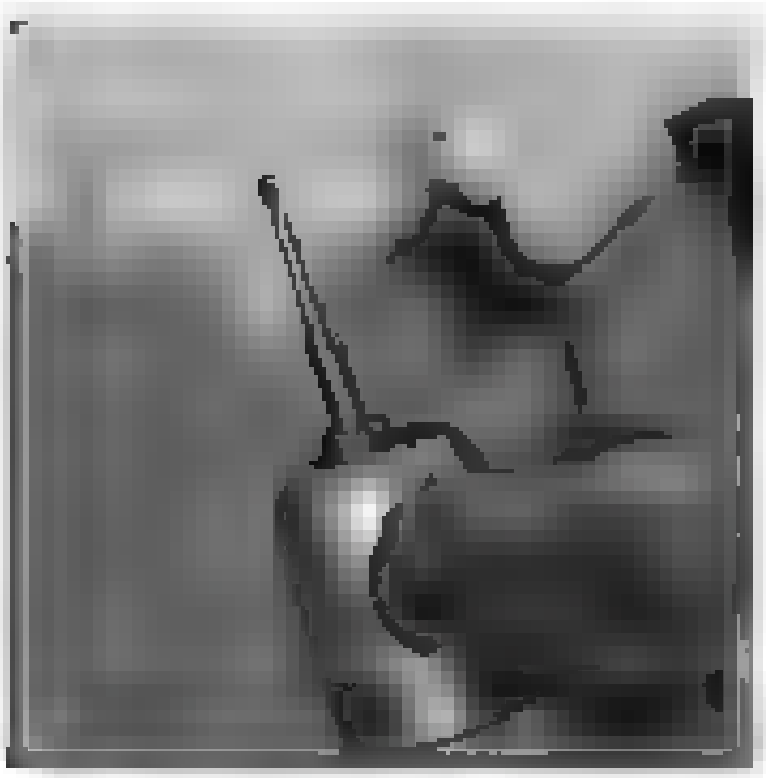


Figure 5-37 The buccal cusps of the maxillary right premolars are being reduced.

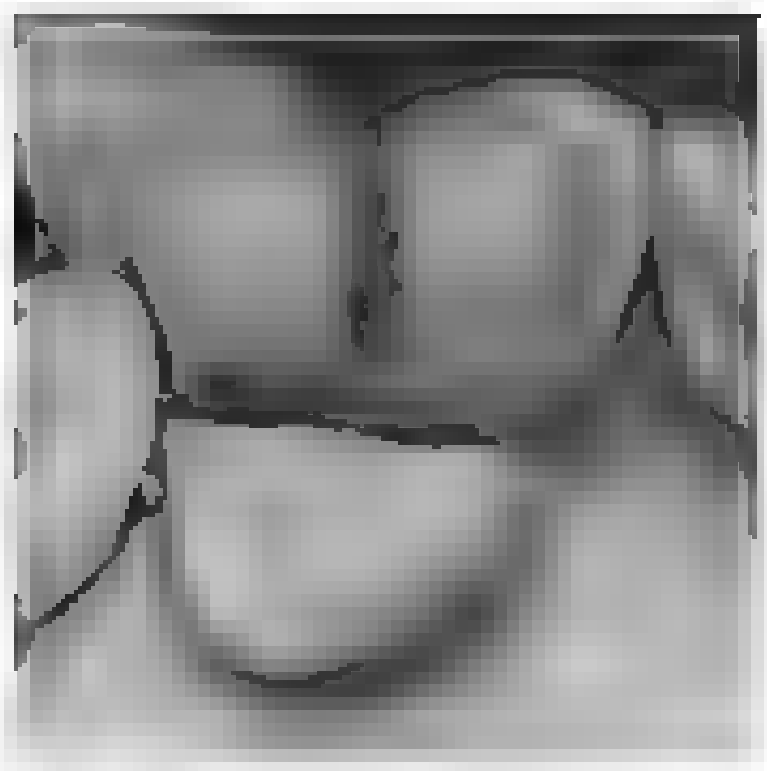


Figure 5.38 [illegible] of mandibular right molar

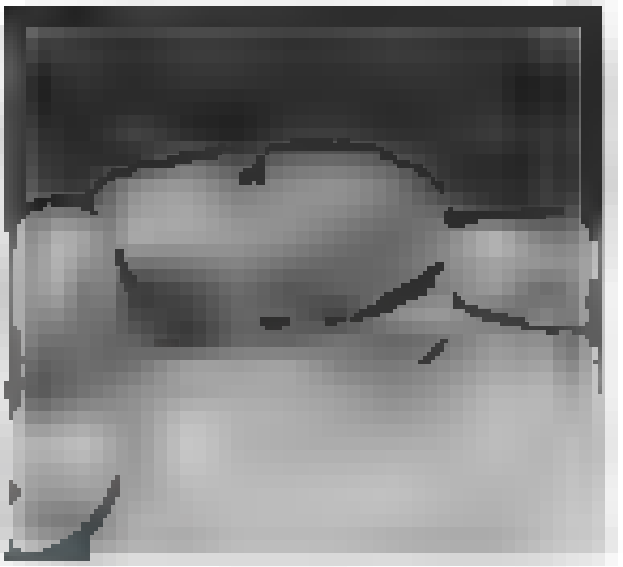


Figure 5.39 [illegible] mandibular right permanent teeth

Extracting persistent deciduous teeth

[illegible] gingival area [illegible] of two teeth occupy the same location the deciduous tooth must be extracted. Persistent deciduous teeth may be found to be unassociated with a permanent tooth or the deciduous or the succedaneous tooth is kept in the mouth as [illegible] it would reduce the number of horizontal teeth (Figure 5.40). The appearance and progress of persistent deciduous teeth are

Figure 5.46 Once the buccal crown has fragmented, the maxillary deciduous teeth have been extracted. [illegible] bone buccal to the palatal root must be removed to facilitate extraction of the crown [illegible] root segment.

Figure 5.47 Persistent deciduous teeth: [illegible] with [illegible] radiographically must be kept in the mouth as they [illegible] mandibular [illegible] deciduous [illegible] permanent [illegible] missing.

sectional (Figure 5.46), as some may be undergoing root resorption and their extraction is accomplished by simply severing the gingival attachment [illegible] using a scalpel blade or a sharp curette.[illegible] When the roots are visible radiographically, surgical extraction is indicated (Figure 5.47).

Figure 5.62 Panoramic radiograph
Teeth must be radiographically present in the maxillary central incisor area to check orientation. In this case, both the mandibular right permanent deciduous canine (**84**) and the lateral incisor (**82**) have already undergone the first part of the surgical exposure performed by loosening the gingival attachment using a scalpel blade.

Figure 5.63 Panoramic radiograph
Teeth which have been treated should be carefully monitored.

The surgical dressing as described earlier has now been removed and the wound area is clean. Some granulation tissue has formed over the exposed crown of the tooth (Figure 5.64). The granulation tissue can be removed with a sharp curette (Figure 5.65). Once the dressing has been removed, the patient should be instructed to rinse their mouth with warm water after meals and to avoid brushing the area for a few days.

Figure 5.64 A large mucoperiosteal flap is raised to expose the full extent of the periodontal destruction on the facial aspect of the maxillary anterior teeth.

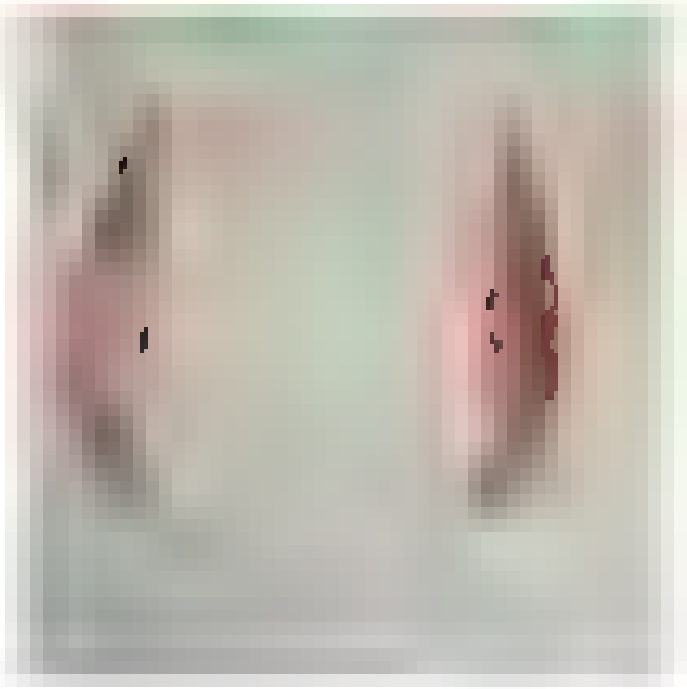


Figure 5.65 The periosteum is sutured with interrupted sutures of 3-0 chromic gut. The flap is sutured

and the alveolar bone exposed, an alveoloplasty is performed to reduce the buccal bone beginning mesially at the neck of the tooth and ending distally at the neck of the next tooth (Figure 5.66). After adequate bone has been removed to expose the periodontal ligament, which is then incised using a scalpel blade (Figure 5.67). Once the gingival margin has been incised on the palatal surface of the tooth it can then be lifted from the alveolar bone using an elevator and the soft tissue sutured in sequence to the one used but can even be extended one or two teeth distally to ensure adequate soft tissue coverage of the bone (Figure 5.68).

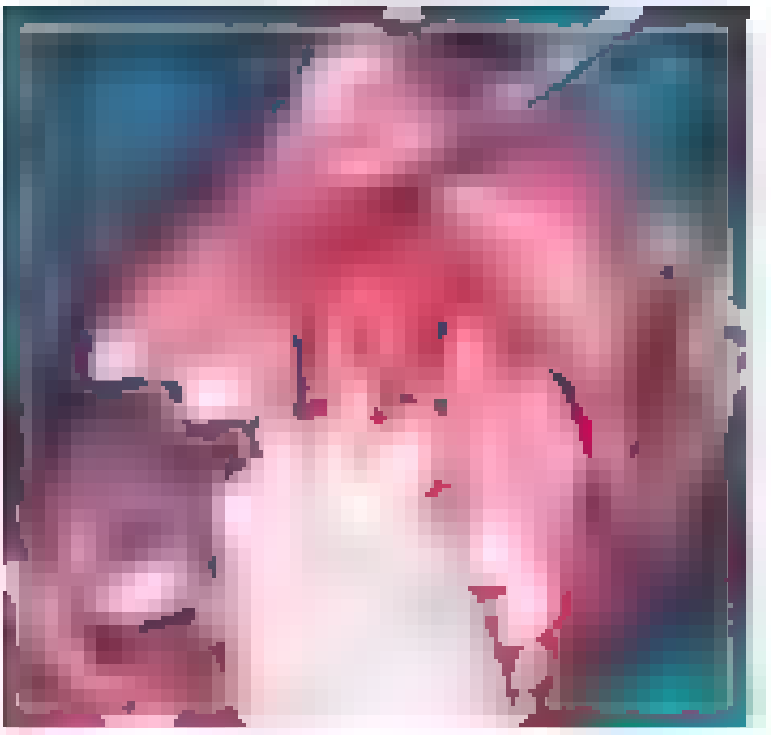


Figure 5.46 Abscessation perforated around the whole gingival margin, causing the periodontal ligament

Figure 5.47 The periodontal ligament is exposed using a scalpel blade and once the pocket (segment of attached gingiva is incised) the tooth can either be delivered from the alveolus using the thumb and forefinger.

permanent tooth (Figure 5.46). This may occur under previous or concomitant periodontal pathology and can result in chronic hypersensitivity due to damage to dentinal tubules. Treatment options include root canal therapy followed by gingivectomy and crown lengthening.

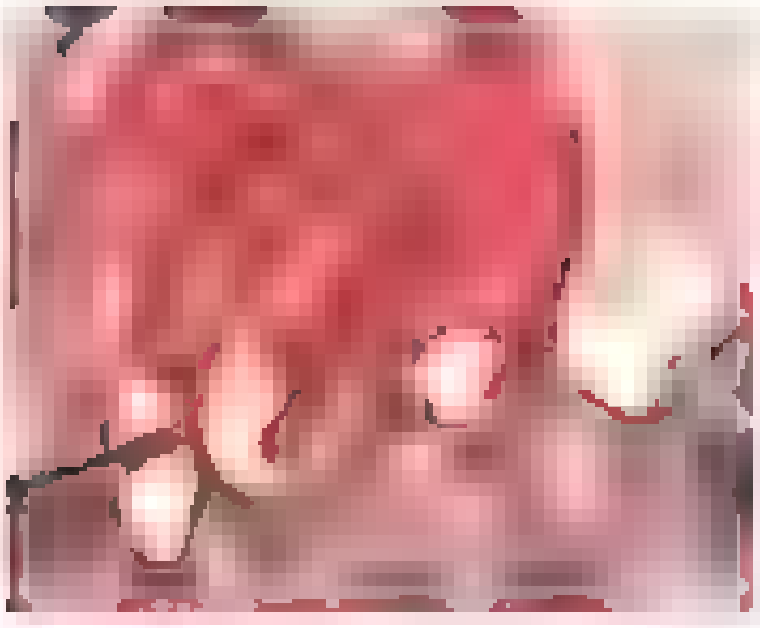


Figure 5.48 Do not place a space between the crowns of the second primary and permanent teeth and risk damage to the crown of the developing permanent tooth bud.

Figure 5.49 The permanent teeth have longitudinal developmental grooves down from the crown and medially on the distal root. Attachment and periodontal disease may thus be more extensive than expected.

Possible complications associated with extractions

The mandibular molar and maxillary permanent teeth may have a developmental groove running down the lingual or palatal root (Figure 5.49). These grooves provide additional area for plaque to attach to the tooth and can result in these extractions taking longer than expected.

Figure 5.78 A transverse section of the maxilla and mandible showing the mandibular canal and premolars and molars with communications between the root canals and the oral cavity. The bone is stained pink.

Figure 5.78 The acute oral mucosal ulceration and exposure of necrotic bone (sequestrum) in the maxilla of this Shetland Pony gelding.

Further reading

Alexander, D.A. and Parker, S. (Eds) (1991) Manual of Small Animal Soft Tissue Surgery. Blackwell Scientific Publications, Oxford.

Bellenger, C.R., Blood, D.C. and Studdert, V.P. (1983) Veterinary Clinical Pathology for the Small Animal Practitioner. 2nd edn. W.B. Saunders Company Limited, London.

Bellenger, C.R. (2000) Oral Examination. In: Practical Guide to Canine and Feline Dentistry. 3rd edn. Pergamon-Reed Educational, Oxford.

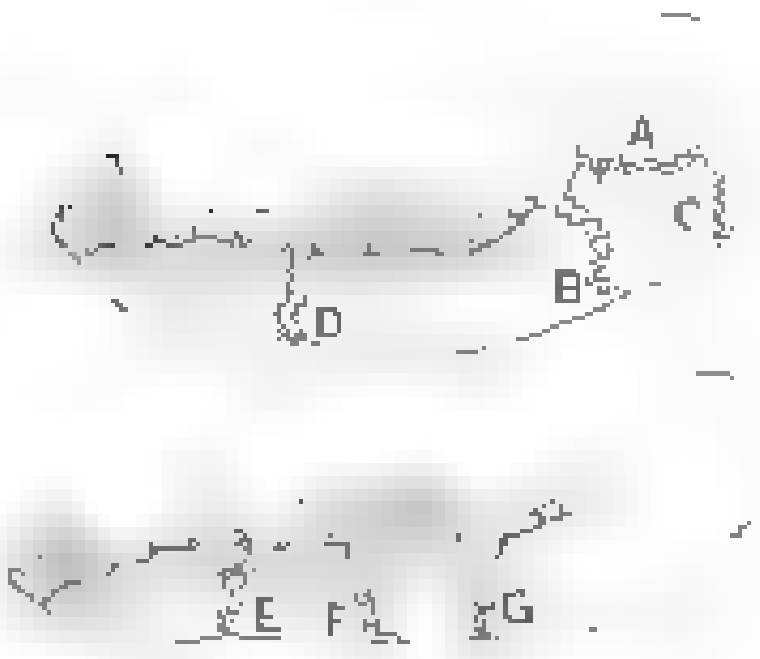
Riggs, R.S. and Kirpensky, P.B. (2001) Veterinary Dentistry: Principles and Practice. Lippincott-Raven Publishers, Philadelphia.

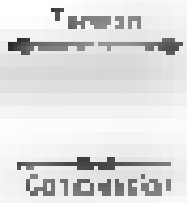
Mandibles do not have a medullary cavity. The mandible bears a number of important structures, namely the nerve and arterial alveolar anastomoses running through the mandibular canal which complicate repair of mandibular fracture. In young animals with deciduous teeth, more than half the space in the mandible is occupied by tooth buds. Because the developing permanent dentition competes with the mandible for muscular attachment sites on the mandible.

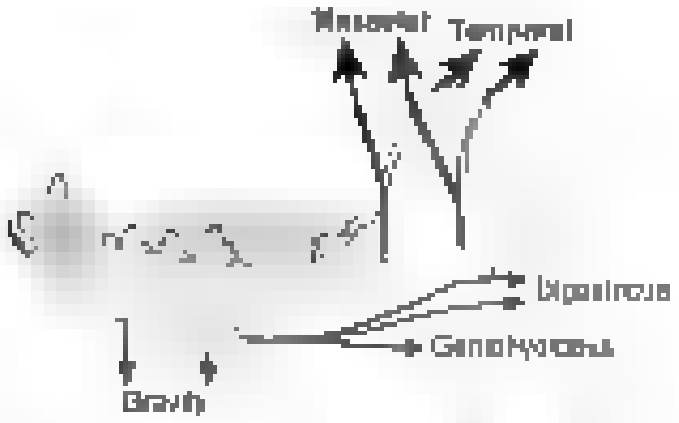
Jaw fractures are common following motor vehicle accidents and cage fights. Jaw fractures are unlikely to undergo union although pathological fractures can occur in geriatric animals with severe periodontal disease which has compromised the integrity of the body of the mandible and alveolar process (Figure 6-4A).

In practice, the temporal muscle tends to pull the rostral fragment aggressively dorsocaudally and the caudal fragment will often tilt ventrally as the fracture progresses (Figure 6-4B). Displacement of the rostral fragment is limited by the contact between the opposing mandibular canine teeth (Figure 6-4C). Fractures are usually described according to the number of fracture lines present (Figure 6-4D). Multiple fracture lines may result in comminution (Figure 6-4E). Avulsion fractures will result if the periosteum and gingiva are torn off the bone (Figure 6-4F). Fractures of the mandibular symphysis (Figure 6-4G) are rare.

Figure 6-4 Common Sites for Jaw Fractures:
A. Mandibular symphysis
B. Junction of ramus and mandibular body
C. Coronoid process
D. Body of the mandible
Tooth misalignment in fractures:
E. Avulsion fracture of the tooth root as well as the tooth crown
F. Displaced mandibular symphysis fracture with the rostral fragment displaced ventrally and rotated, resulting in the canine tooth on the rostral fragment occluding with the mandibular canine tooth on the caudal fragment. There is also a fracture of the left mandibular canine tooth root.
G. Fracture-separation of part of the tooth bud. The space is not large enough for there to be a fracture of the mandible as the tooth root is not large enough to affect the mandible.







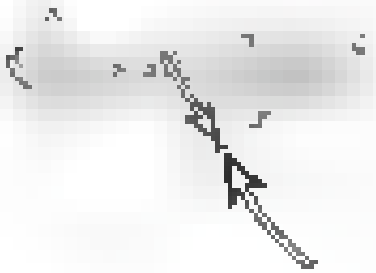


Figure 8.2 The muscles are subject to opposing forces. The masseter and temporal muscles close the mouth while the digastricus and geniohyoid muscles open the mouth. The dorsal margin of the mandible is the tension side, while the ventral mandibular margin is under compression.

Figure 8.3 The forces acting on the mandible can be resolved into dorsoventral or anteroposterior components. A force with a dorsoventral component will cause the fragments to distract. A force with a ventral to dorsal component will cause the fragments to compress.

to a full length. When an endodontic [illegible] treatment on the remaining sections of the tooth.

Fracture repair techniques

Tape or fabric muzzle

The tape muzzle is used to keep the jaws stabilized and the teeth in occlusion. The initial layer of tape – cloth adhesive tape is best as it does not stretch – is placed with their sticky side out; however, as animal skin is undesirable for the tape to adhere to the patient's skin or facial hair. The loop around the muzzle must be small enough to prevent the canine teeth from coming out of occlusion and large enough to allow the animal to lap food and water and pant when warm. The loop extending from the muzzle around the base of the ears must keep the muzzle loop from sliding down the nose. The second layer of tape is placed with the sticky side adhered to the sticky layer of the initial layer of tape (Figure 6.4).

Fabric muzzles are available which support the mandible while keeping the animal in occlusion (Figure 6.5).

The management of tape and fabric muzzles is of paramount importance. After each meal the muzzle must be removed, cleaned and replaced once the animal's face has been cleaned and dried. Wet muzzles lead to facial skin maceration and dermatitis. Alternatively two or three muzzles can be used and rotated with the used muzzle washed and allowed to dry for use again. Tape and fabric muzzles are not only ineffective in brachycephalic breeds due to their head and face shape, but are also contraindicated as these breeds often rely on open-mouthed breathing to aid in respiration.

Interfragmentary wiring

Interfragmentary wiring may be performed as long as it is possible to place the wires without compromising tooth roots. The wire can be placed using either a two-, three- or four-hole configuration. In the two-hole configuration

Figure 6.4 A tape muzzle in place. Care must be taken to ensure that the animal has access to food and water. The face must be cleaned [illegible] muzzles must be fitted. The animal should not be left unattended between muzzle changes.

Figure 6.5 Fabric muscle sensors used in neuromuscular stabilization. The sensors are placed parallel to the muscle fibers in the upper right corner of the patient's right arm and connected to a portable device. The sensors are placed one at a time with a wash cloth after each. Note that preventing muscle overload is desired.

are placed perpendicular to the bracket face while in the three-tie configuration, one tie is placed on the canine bracket and two ties are placed on the central bracket, ending posterior stability in the space. The distal wire is placed close and parallel to the distal gingival margins and the mesial wire is placed perpendicular to the bracket face in four ties technique. two wires are placed parallel to each other and perpendicular to the bracket face (Figure 6.6).

Intermaxillary wiring

Intermaxillary wires may be used to stabilize a fractured condyle or numerous teeth as a quadrant.

Place a loop of wire between the teeth on either side of the fracture and then pass the free ends around the mesial and distal aspects of these teeth. Take the loop and which one was used and the distal aspect of the maxillary teeth and pass through the loop spanning between the two dental arches to the buccal of the mesial aspect of the mandibular teeth. Your tie once these have been twisted together the maxillary loop should be twisted to complete the fixation. Two patients can be connected to include all teeth on a quadrant and more severe circumstances extend to the contralateral side to improve stability (Figure 6.7 and 6.8). Intermaxillary wiring may also be performed by placing a wire circumferentially around the mandibular teeth and distally around the maxillary teeth to be stabilized and the loops ends twisted together (Figure 6.9).

Intermaxillary elastics

An intermaxillary elastic ligature can be applied to the teeth on either side of a bracket to provide light intermaxillary forces as long as there are teeth

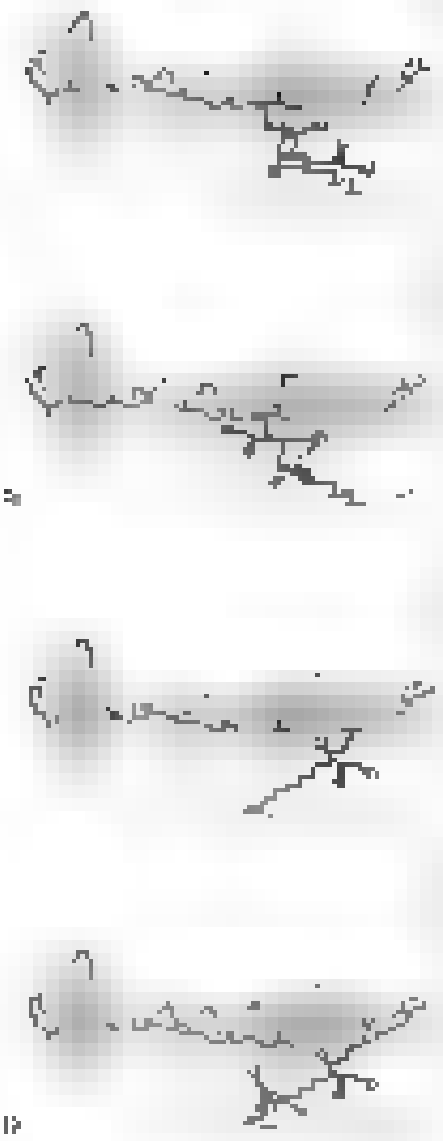
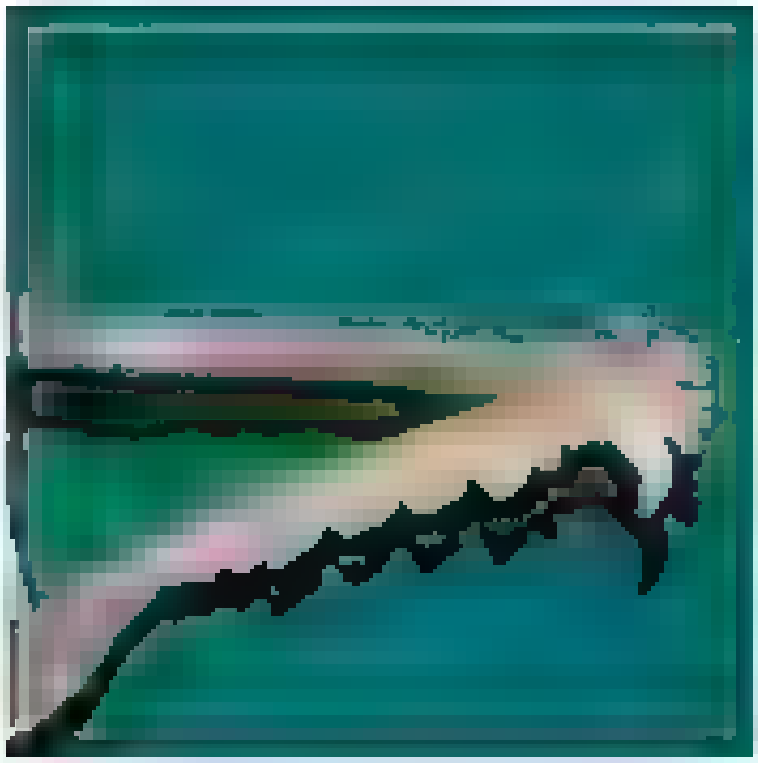


Figure 8.8 Inter-fragmentary wiring. A: Although the three-hole arrangement is correctly placed according to the rotation, there is a possibility of damage to the root in the anterior region. B: The arrangement of the three-holes were placed by making use of the bi-cortical screws and the lower border tension. The direction is parallel to the lower border and the normal wire is perpendicular to the fracture line. C: Four-hole wire placement for favourable fracture was noticed. The wires are placed vertically close to the fracture line and are observed vertically close to the fracture line. D: The four-hole wire placement configuration. Both wires are arranged perpendicular to the fracture line. The wires should be taken care to place it very close to the lower border of the mandibular canal

on either side of the fracture. The base of the acrylic should be applied to the buccal surface of mandibular teeth (vestibular embrasures) and the lingual surface of mandibular teeth (mandibular embrasures). To prevent interference with occlusion. When using materials which undergoes an exothermic reaction it is important not to place too much of a layer against the teeth as the heat of thermal activated polymer may result. When using exothermic materials, a second layer should be applied until the desired thickness is attained (Figure 8.9). Circumferential wire-pin wires are to be placed around the mandibular and incorporated into the acrylic to provide stabilization of fracture area.

Inter arcade acrylic bonding between mandibular and maxillary occlusal surfaces is sometimes indicated. This technique may consist of a combination of inter-fragmentary wiring and inter-dental acrylic splint in order to stabilize. The cases are banned together using dental acrylic or dental temporary material



wed the rawa oral spur anteriorly to allow tapping of bone but not to the spur as to prevent swallowing. Prior to bonding the teeth together, the endodontic EJ rods must be active and should be removed from the tube. Internal obturation should not be removed during recovery from anaesthesia. It is also important to ensure that the full undercut is maintained

Figure 6.3 A simple loop of wire can be placed mesially around the central tooth and distally around the second tooth in either order. The ends of the wire are then twisted together.

Figure 6.10 Interdental acrylic can be used to create a gingival flange to help hold acrylic should be placed lingually to the mandibular incisors and buccally to the maxillary canines in order to prevent interference with occlusion.

straight ends of the ET tube between the second and third will become trapped at each bend. Placement of an endotracheal tube may be important to maintain airway patency and prevent aspiration of blood and swallowed blood. When patients have severe swelling in the throat, they may require a tracheostomy to bypass the swelling and allow breathing through a tube placed directly into the trachea.

Circumpolar wires and pins should not be placed within the mandibular canal unless an extraoral approach is used. This may involve placing an access hole in the lower border of the mandible to allow access to the inferior alveolar blood vessels and nerve which course through the mandibular canal. When applying circumpolar principles to mandibular fracture repair, the rule that the dental margin of the mandible is the weakest area should be remembered. Circumpolar devices must be placed above the dental margin. However, the crown should not

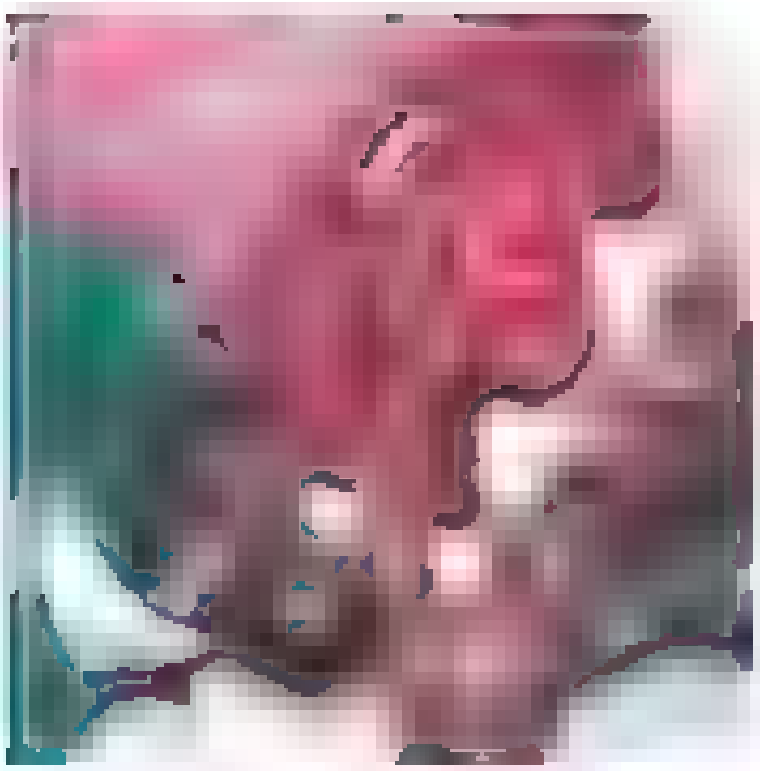
Figure 4-19 Holes that may be drilled at risk through the mandible. An incisor tooth can be safely drilled through the mandible just through the medial root. The mandibular left premolar 4 can be drilled through the medial root of the 3rd premolar (beneath the vertical) and the third through the separation of roots of 3rd and 4th premolars (beneath the vertical). Unprotected nerve at risk.

secured within the dental ball. The mandible and this precludes the use of bone plates and screws. External fixators may be used and the most common between rods supporting a bone fragment anchored via percutaneous pins. Pins should not be placed through tooth roots. If an external fixation pin is to be placed through the mandibular canal, consider the diameter of the lower dental nerve. If you then half the width of the canal in order to avoid damage to the inferior alveolar neurovascular bundle. Pins should be placed using a low speed drill to prevent damage to these structures and must be placed either at the most ventral part of the canal or at the most dorsal part. Intra-trabecular wires may be passed through each cortex of the canal. The neurovascular bundle must be protected by the drill by using a protector sleeve and not be blindly drilled through the mandible as this inevitably results in damage to neural structures (Figure 4-19 and 4-20).

Soft-tissue injuries must also be addressed when treating jaw fractures. Commonly seen soft tissue injuries include stripping of the gingival alveolar mucosa and penetration from the teeth of the mandible. Careful debridement of compromised mucosa should be performed prior to suturing to avoid sequestra. The lingual and sublingual mucosa and associated tissues can also be damaged and should be thoroughly cleaned and sealed appropriately (Figure 4-21).

Occlusion is one of these anatomical very important and the placement and maintenance of an occlusal splint should be considered as soon as swelling and pain has been addressed.

Mandibular symphysis separation can be repaired using wires or polydioxanone resorbable sutures. Circumferential wires can also be used for this purpose. Thick polydioxanone sutures should not be used as inevitably leads to bone impingement which is undesirable. Traumatic soft tissue and palatal mucosa lacerations are best sutured with placement of subcutaneous sutures. Bridging of the wound and secured by external sutures. The wires must be removed together should be the wound is fully healed and the fracture is clinically stable (Figure 4-22).



Further reading

[illegible]
[illegible]
[illegible]

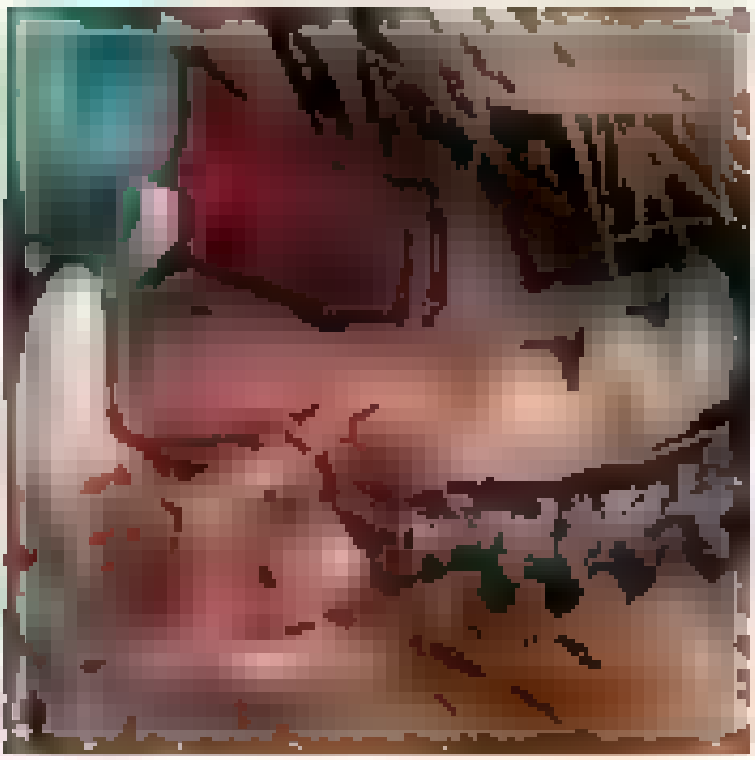
Gingival overgrowth (hyperplasia) is more commonly seen in dogs than cats and some dog breeds are more predisposed to gingival hyperplasia than others (e.g. Boxer dogs). Gingival hyperplasia may affect one tooth or many teeth and excised tissue should be submitted for histopathological examination to rule out neoplasia.

Hyperplastic gingiva should be recorded on the dental chart by drawing an outline around the affected teeth. The extent is noted with distances measured using the periodontal probe. It is considered [illegible] tissue, though some have a good blood supply requiring ligation (Figure [illegible]). In some cases the gingiva [illegible] teeth and [illegible] (Figure [illegible]).

The depth of pseudopockets is measured (Figure [illegible]) [illegible] against the [illegible] surface of the [illegible] by puncturing the gingiva using a dental explorer. The [illegible] of the pseudopocket, which is detected by bleeding points [illegible] hyperplastic tissue [illegible] by placing a scalpel blade against the gingiva just apical to the bleeding points and incising at an angle which bevels the tissue [illegible] to the floor of the pseudopocket. The bevelled incision attempts to restore the gingival margin [illegible] of the pseudopocket (Figure [illegible]). It may be necessary to replace the scalpel blade [illegible] of the fibrous tissue. Bleeding may be profuse but can usually be controlled by digital pressure using a gloved finger [illegible] gauze swab. [illegible] removes the [illegible] blood [illegible] bleeding.

Excised tissue must be submitted for histopathological examination to rule out neoplasia.

Figure [illegible] A large [illegible] [illegible]. These masses have a good blood supply which may require ligation at excision.



The use of laser surgery has been described but there is insufficient evidence to address the use in this procedure. Each surgical approach should be considered on its own merits and there is a danger of thermal damage to the ureter and surrounding tissues.

Figure 7.6 The diagnosis of periodontitis is established basically by detecting destruction of the supporting tissues (periodontium) marked during a dental exam by increased bleeding point

Figure 7.7 An increase in mobility is the bleeding point, eliminating the periodontium

Oro-nasal communications - acute and chronic

Acute oro-nasal communications caused during extraction of a periodontally compromised tooth (Figure 7.8) or the post-surgical evolution of oro-nasal communications (Figure 7.9) are removed by primary closure

:Figure If the tunnel or deep pocketing depth the walls of the pocket will have been :preclusioned area the material must be debrided prior to closure. The margin of the pocket must also be debrided to remove :compromised tissue which may cause repair failure. If there is no remaining attached

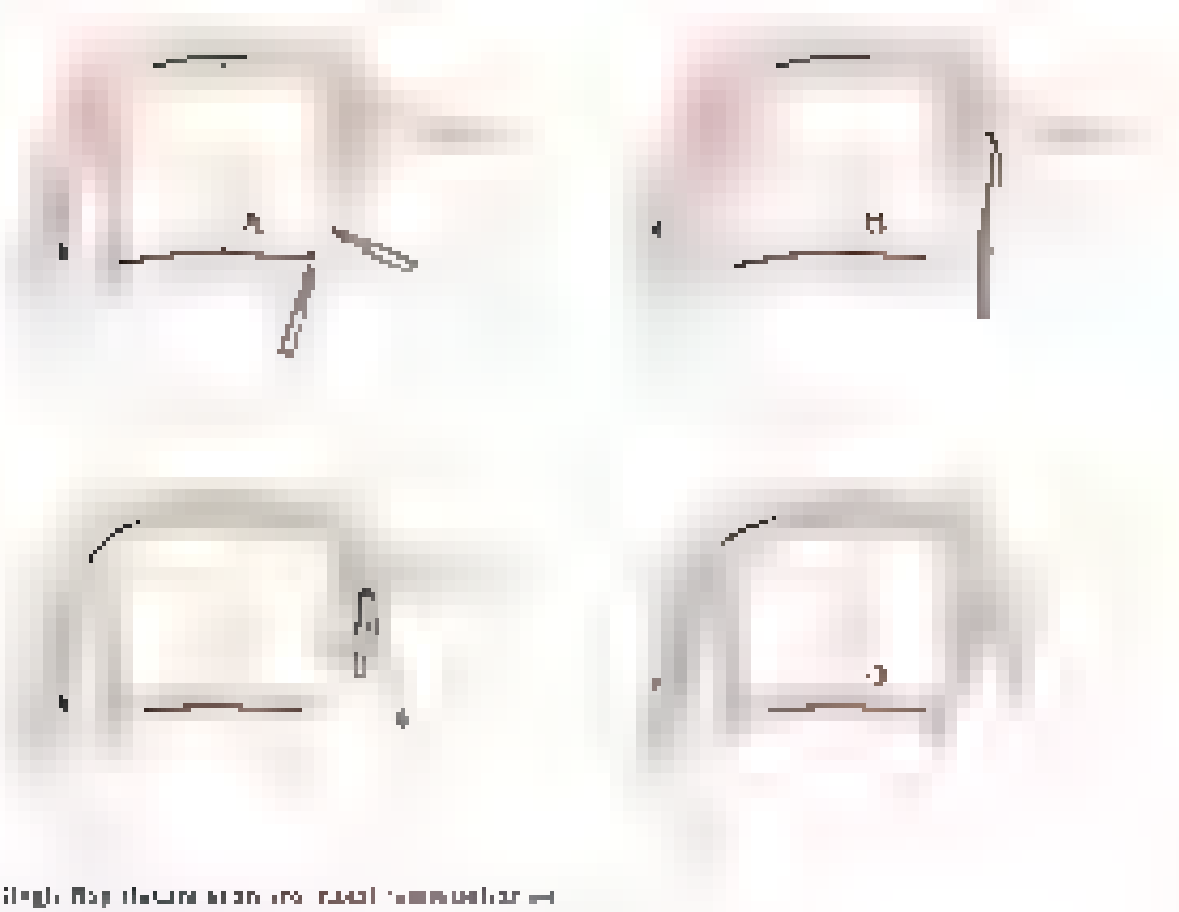


Figure 7.4 Single flap closure of an oro-nasal communication
A: The edges of the defect are outlined
B: An anterior mucoperiosteal flap is raised, extending beyond the mucogingival line
C: A horizontal mattress suture through the periosteum at the base of the flap is extended to reach the nasal mucosa, taking care that the needle does not perforate the nasal mucosa. The suture is then passed through the palatal mucosa from the bony palate to the oral cavity
D: The flap is advanced and sutured in its new position using interrupted sutures

purpose. A full thickness mucoperiosteal flap should be raised, extended as a relaxing incision mucosal flap and advanced over the defect to close it. The leading edge of the flap may be rounded to fit the defect and will also cover bone exposed at the flap edge (Figure 7.4). The flap must be sutured using resorbable sutures to prevent a second operation to remove sutures.

Cleft palate

The hard palate and naso-nasal mucosa may be cleft following haphazard syndromic and other anomalous sequence. As long as the maxilla is not cleft, one may recruit surgical repair the palatal mucosa can be achieved using a simple mucoperiosteal flap technique. Unstable flaps undermine healing (Figure 7.5).

Congenital cleft palate is also an anomaly from cleft to nose and bone palate should be planned to fill gaps with cancellous bone graft. At the time surgery was undertaken usually bone has been prepared for complete repair

Figure 7.3 An palatal mucosa was anatomically mobilized and the oral mucosal flap was sutured with the underlying gingival tissue prior to surgery. Scale and gallith formation underwater prior to oral surgery was not done in this patient to prevent removal from entering the oral cavity. (Photograph kindly provided by Dr Dana Graves)

Connective tissue grafts can be used during a single advancement flap or double flaps. When using the double flap technique the epithelial lining of the lamina should be extended as above except in the area where the first flap is to be raised from the palatal mucosa with margin. The first flap is sutured down the palatal and tunnel at the buccal margin of the defect. The flap is sutured into the defect with the connective tissue overlying the bone with no tension passage. A second flap is raised, beginning at the buccal margin of the defect, extending into the buccal mucosa so that it can be advanced over the defect and the area from where the first flap was harvested. The flap is sutured in such a way that it completely covers the bone flap harvest and without tension (Figure).

It is important to remember when raising these flaps that the tissues are dense and although they can be sutured immediately after harvesting they will shrink slightly and cause tension which may lead to tissue loss. When planning the flap it is best that there is sufficient tissue to cover the defect with about half as much as space. In other words, if the defect is 6 mm across, a flap will be needed which extends 9 mm or more to cover the defect prior to suturing. The natural post-harvest shrinkage should therefore not cause tension and dehiscence.

Periodontal surgery

In patients with deep periodontal pockets, gingival depth reduction techniques are used to maximum the achievable width.

In some cases partial gingivectomy may achieve the desired effect with sufficient gingival coverage and if there is minimal bone loss present, no bone harvest

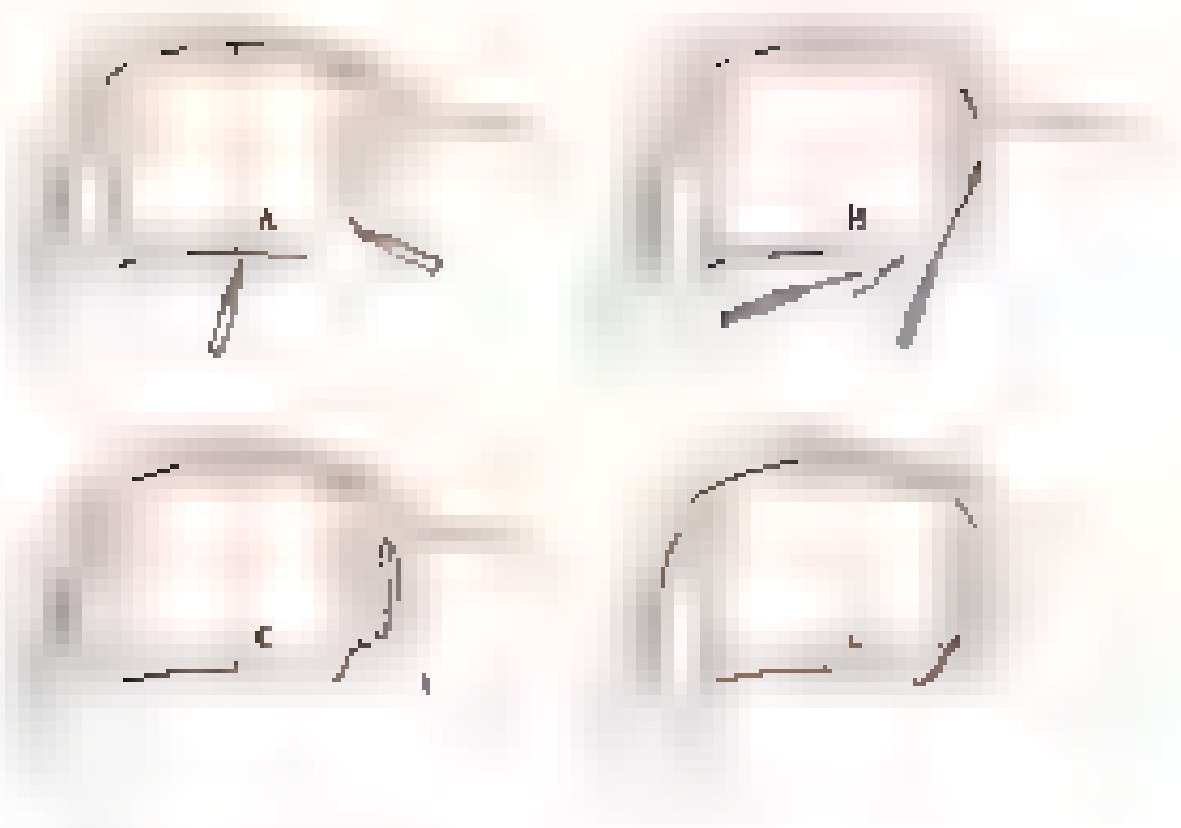


Figure 7-18 Double-flap closure of oro-nasal defects.

A. An incision is made at the junction of the palate and alveolar ridge to create the anterior portion of the first flap. The incision is made through the palatal mucosa at a distance from the palatal margin of the defect. This will permit a flap to be raised to line the nasal anterior portion.

B. Both flaps have been elevated and sutured.

The first flap is raised from the palatal to nasal surface without tension, using synthetic, monofilament absorbable sutures to close the nasal anterior portion of the buccal flap. The second flap is elevated as shown in Figure 7-18.

C. The second flap is sutured to the palatal mucosa overlapping the area where the first flap was harvested from.

dehiscence. At least a band of attached gingiva should be retained when performing this procedure.

In some patients it may be necessary to excise the inflamed gingival margins and raise a mucogingival flap, removing some underlying bone and/or soft tissue prior to the first stage suture back to place (Figure 7-19).

Some patients are at the edentulous stage with significant bone loss (Figure 7-20), and it is also where reversible lesions should be surgically excised. Care must be taken when planning excision of gingival lesions as they may be an early presentation of aggressive neoplasms (e.g. squamous cell carcinoma). Some patients have their dentures made over existing pre-malignant lesions (Figure 7-21 and 7-22). In these cases surgical excision of the lesion, palate and overlying denture is required.

Mucoperiosteal flaps for surgical access to the palate are described in Chapter 8 Exodontia.

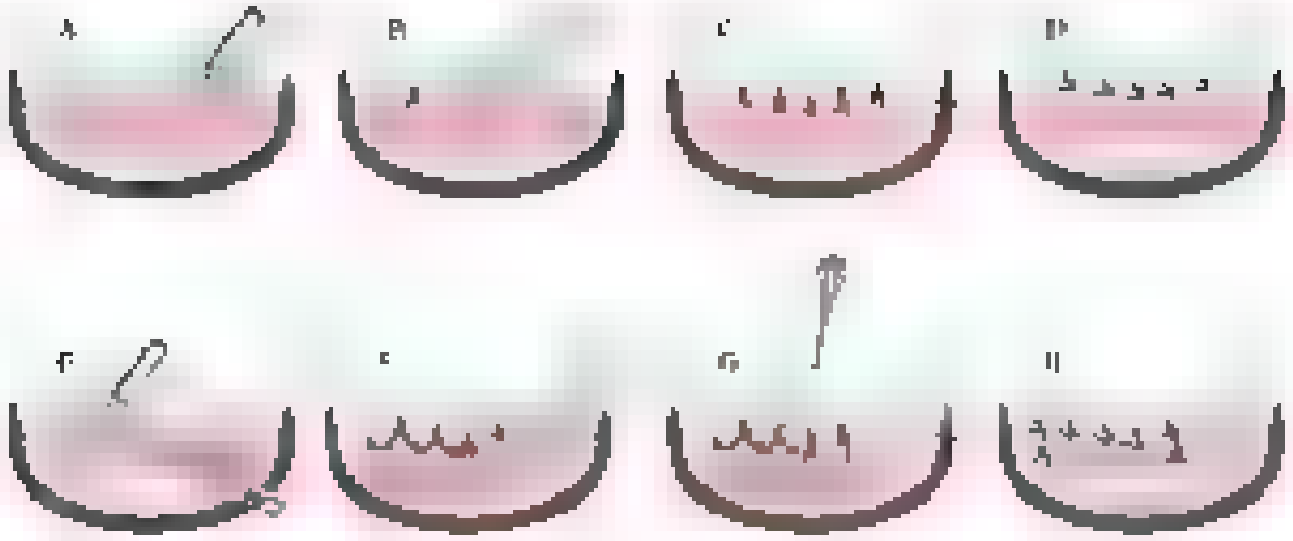


Figure 7.18 Periodontal surgery.
A The inflamed gingival margin and pocket.
B The attached gingiva is elevated from the alveolar bone using a periosteal elevator to avoid tearing the gingival margin.
C Subgingival plaque and calculus is removed.
D The flap is sutured back in place using interdental sutures.
E The deep pocket
F The gingival margin is sutured in place to reduce the pocket depth.
G Bone recontouring is performed, including any debridement of necrotic cementum. Bone debridement would be undertaken primarily to prevent damage to the dentine.
H The flap is sutured in place in a slightly apical position in an attempt to eliminate the pocket. Note that some cementum is exposed coronal to the gingiva.

Figure 7.19 Severe periodontal disease with gingival recession. This is a moderate form of the condition and does not require surgery. The inflammation is confined to the gingival margin and has not spread to the adjacent tissues.

[illegible]

Further reading

[illegible]

The most common cause of wound dehiscence is tension on the suture line. Tension must be minimized, because high tension can compromise the blood within the tissues and prevent adequate healing. When tension on the wound edges becomes too great, the sutures may tear through the tissue, causing the wound to open.

To avoid tension, surgeons must take steps to reduce the tension on the wound edges. These steps include:

- Choosing the right suture material for the job
- Using the correct suture technique
- Avoiding excessive tension when tying knots
- Not placing sutures too close together
- Not using sutures that are too small
- Not using sutures that are too large

In addition to these steps, surgeons must also be aware of the tissue's natural tension lines. These lines are the direction in which the tissue is most likely to stretch. By placing sutures parallel to these lines, surgeons can minimize the tension on the wound edges.

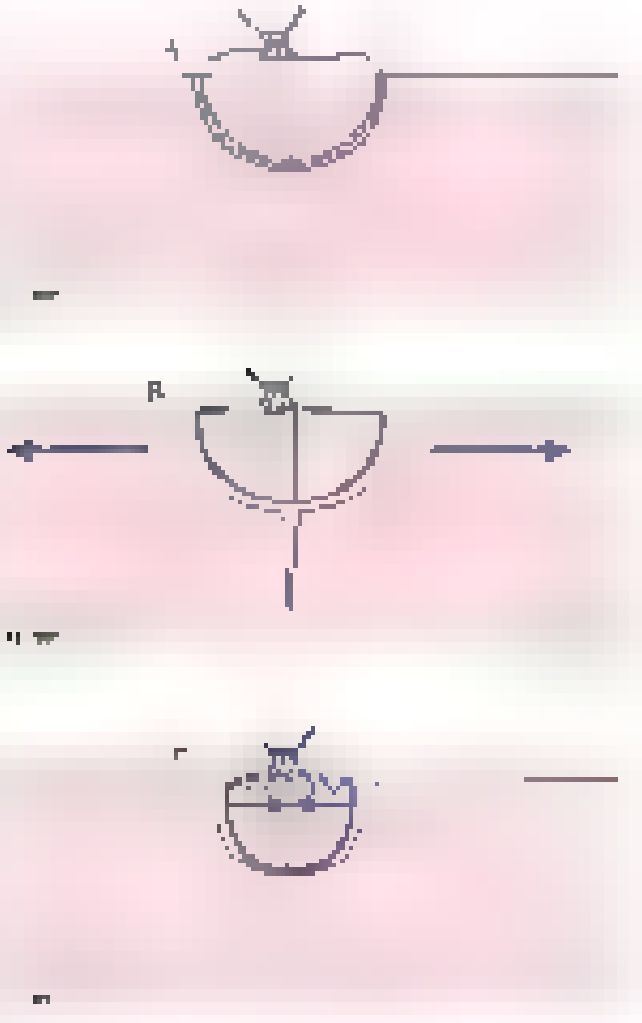


Figure 1. Tension control.
A. Sutures placed parallel to the tension lines of the tissue, minimizing tension on the wound edges.
B. Sutures placed perpendicular to the tension lines, increasing tension on the wound edges.
C. Sutures placed at an angle to the tension lines, reducing tension on the wound edges.

Material	Material origin	Material type	Filament	Absorbable	Ability of manipulation	Possibility for surface modification	Loss of strength (days)
Catgut	Natural	Collagen	Multifilament	Yes	Adaptable	No	7
Vicryl®	Synthetic	Polyglactin 910	Multifilament	Yes	Pliable	Average to poor	42
Vicryl Rapide®	Synthetic	Polyglactin 910	Multifilament	Yes	Pliable	Average to poor	14
PDS®	Synthetic	Polydioxanone	Monofilament	Yes	Pliable	Poor	>56
Monocryl®	Synthetic	Poliglecaprone	Monofilament	No	Pliable	Good	
Caprosyn	Synthetic	Polyglycolide	Monofilament	Yes	Pliable	Good	
Nylon	Synthetic	Polyamide	Monofilament	No	No	Average	Indefinite

Table 8. Commonly used absorbable suture materials for oral and maxillofacial surgery

Multifilament suture materials are characterized by a twisting or braiding pattern of several individual filaments. This design makes multifilament suture material more flexible and easier to handle. However, multifilament suture material has a greater tendency to harbor microorganisms and cause infection. Because of this, multifilament suture material is not recommended for use in contaminated wounds.

Monofilament suture material is composed of a single filament. Monofilament suture material has the least tendency to harbor microorganisms and cause infection. However, monofilament suture material is difficult to handle and tie. Because of its elasticity, monofilament suture material has a tendency to unravel if not tied properly. Monofilament suture material is also more expensive than multifilament suture material.

Absorbable suture material is suture material that is broken down and absorbed by the body. Absorbable suture material is usually used in the oral cavity because it does not require removal. Absorbable suture material is also used in wounds that are difficult to close and may require prolonged support.

Nonabsorbable suture material is suture material that is not broken down and absorbed by the body. Nonabsorbable suture material is usually used in the skin because it can be easily removed after healing has occurred. Nonabsorbable suture material is also used in wounds that require prolonged support.

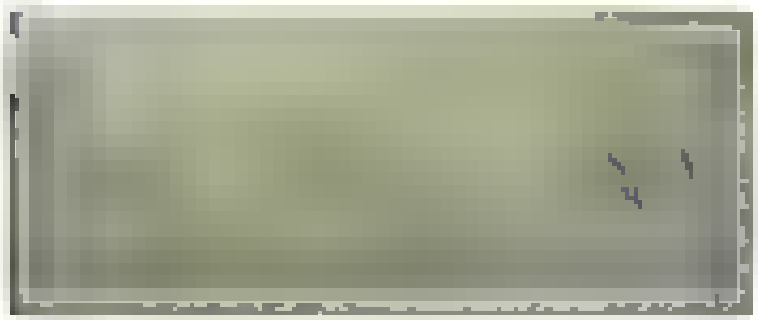
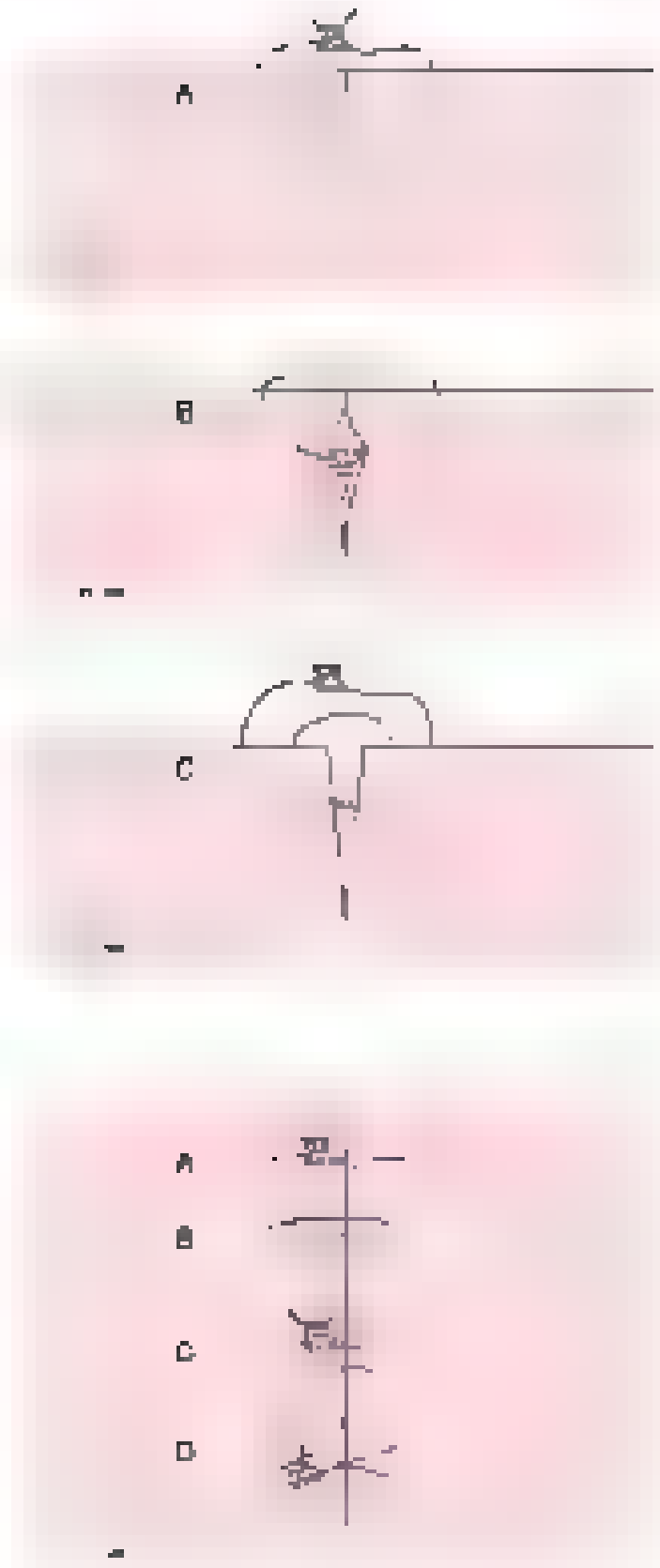


Figure 8.2 An instrument tray with a variety of surgical instruments, including scissors, forceps, and needle holders.


A
B
C
A
B
C
D

D[illegible] clamping and [illegible] the [illegible] hand [illegible] will [illegible] edge to [illegible] (Figure [illegible]). It is good practice not to take hold of the suture material with the [illegible] thus the needle holder [illegible] the strength of the material. Clamping the [illegible] to prevent slippage between [illegible] is not only because it damages the suture material, but also because [illegible].

Suture patterns

The simple interrupted suture pattern is most often used in oral surgery (Figure [illegible]). The [illegible] the pattern [illegible] simple interrupted pattern is [illegible] should [illegible] whole wound edge. Using the buried knot technique, the first bite of tissue is taken deep in the mucosa and the needle brought out submucosally. The second bite is taken submucosally on the opposite side of the wound and the needle brought out deep in the mucosa. Both free ends of the suture material should be [illegible] a surgeon's knot [illegible] tied at the deeper level [illegible] suture material must be trimmed [illegible] appropriate length (Figure 8.3B). The [illegible] can also be placed on the mucosal surface as illustrated in Figure [illegible].

The [illegible] vertical mattress [illegible] can be used to appose and evert [illegible] the wound edges [illegible] (Figure [illegible]).

The [illegible] mattress interrupted suture pattern is also very useful, as it is a tension-relieving suture [illegible] will [illegible] the wound edge as the simple interrupted pattern using a simple reinforced surgeon's knot (Figure [illegible]). The buried knot technique can also be applied to this suture pattern but will require more practice to master. The [illegible] is [illegible] as a simple interrupted suture but instead of the knot being tied after the first pass through each side of the wound, a second pass is made through each side [illegible] on the same line, and then the knot is tied. The loose end of the suture material must be passed through under the second [illegible] of the pattern to [illegible] on the same side as the [illegible] and [illegible] to be performed.

Suture patterns which compromise blood supply to the wound edges (e.g. [illegible]) should be avoided in the mouth.

When knots are placed on the surface they should all be on the same side of the wound and should not be placed directly over the wound edges. [illegible] will provide a straight wound edge. Placing knots on opposite sides of the incision [illegible] a zigzag wound [illegible].

Figure 9.1 Occlusal surface of maxillary right molar

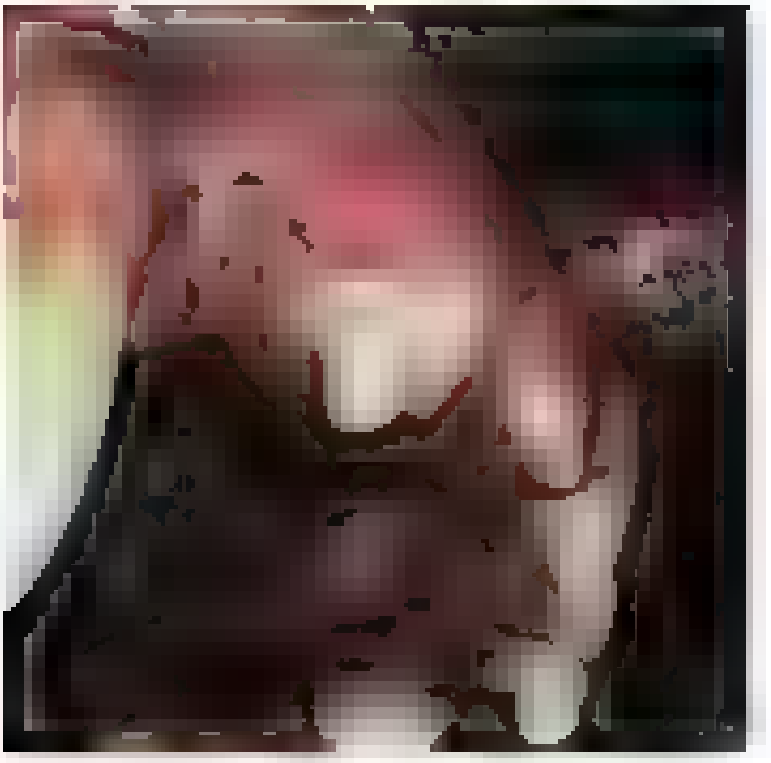


Figure 9.2 Prepared occlusal surface of maxillary right molar

Tooth restoration is indicated where teeth are damaged either by trauma or decay (Figures 9.1 and 9.2) or developmental abnormalities (Figure 9.3) and where restoration is necessary to restore function or appearance following treatment, e.g. root canal therapy. Restorations should not be placed within the gingival sulcus (also known as the periodontal pocket) as doing so leads to gingival

Under a permanent restoration, it is necessary to place directly over exposed pulpal tissue. This base material must be biocompatible, antibacterial, and must stimulate the formation of a dentinal bridge. Calcium hydroxide has been used for many years as a pulp capping material. It is highly alkaline (pH 12.5) and has antibacterial properties. Its ability to stimulate the formation of a dentinal bridge has been questioned.

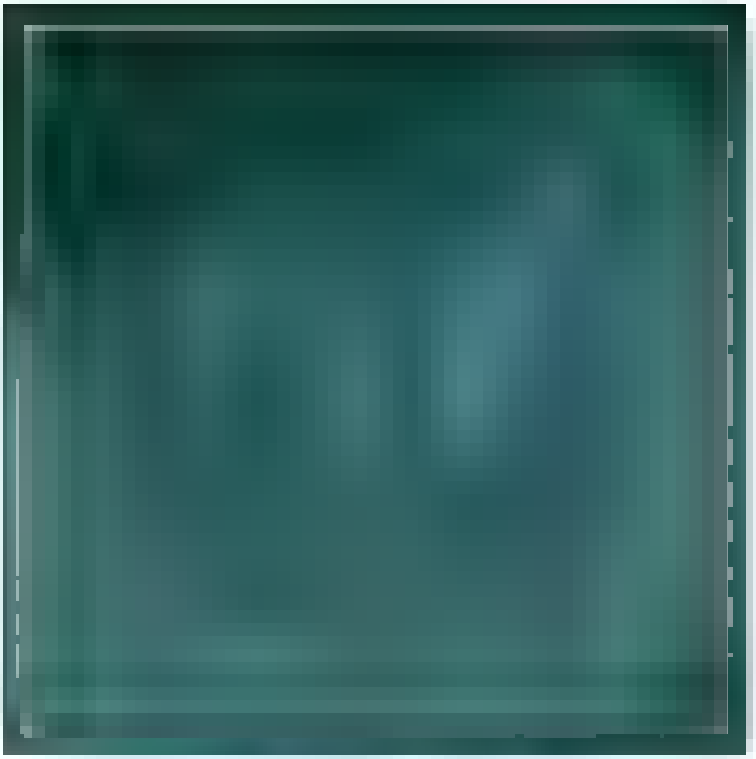


Figure 4.3 An inappropriately placed post in the distal canal. A crack also has been placed unwittingly in the opposite wall, resulting in periapical radiolucency. This tooth was later extracted because of the root-perforation crack that had developed.

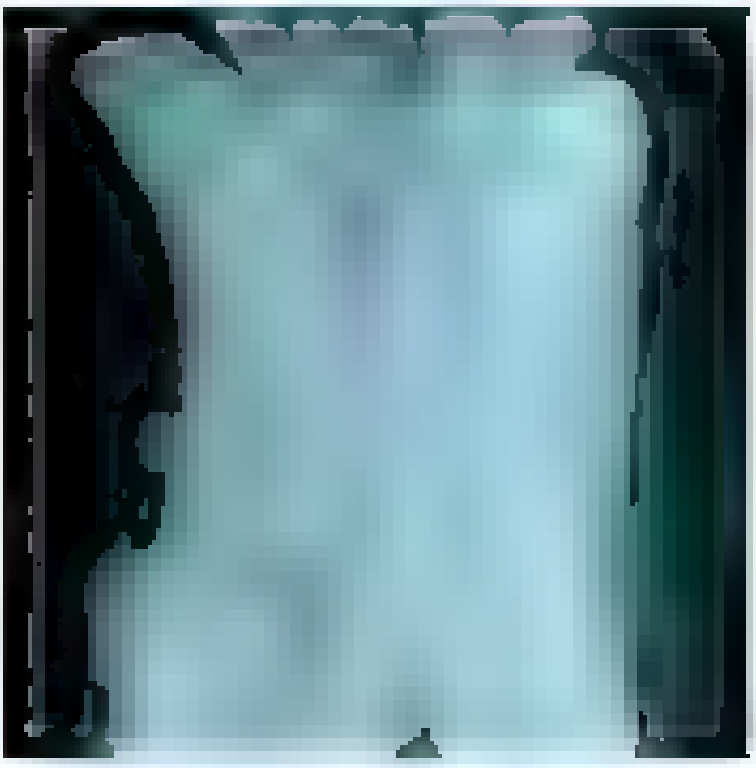


Figure 4.4 A well-placed post that extends into the coronal pulp. The mandibular right canine (left image) has the large periapical lesion seen as a result of pulp necrosis. The difference in width of the root canal at the point of perforation (right image) is an indication that the post in the right canine could fit in the canal without becoming impacted. Post coverage and root formation has continued in the left canine. Root canal therapy was performed on the right canine tooth and the periapical lesion has begun to heal.

Precursors of these cells require antibodies, therapy or vaccination to activate them.

The being forced to adapt and grow into these experiences is our human nature. Materials and human excellence designed for use as small as when adequate

Restorative materials can be used in the cavity to restore lost tooth shape and height and can be combined with retentive pins to help retain the material in the cavity. Pins can be manufactured from various materials, or metal alloys to resemble the original tooth color.

The simplest form of preparation for application of restorative material is a slot or groove following the enamel-dentine junction. The dentine edges may be smoothed using a fine diamond finishing bur or polishing stone. The dentine should then be etched using a gel or liquid to open the dentinal tubules. Exposed dentinal tubules allow pain pathways to be stimulated. Pain can be caused by the movement of fluid in the dentinal tubules, causing irritation to the odontoblasts, pressure resulting in severe pain. The dye in Figure 9.6 had Chlorhexidine Mouthwash with a reading scanner operating. The enamel edges were gently removed using an abrasive paste and a rubber cup.

Figure 9.6 illustrates the step-by-step treatment of a tooth affected by caries.

When teeth are affected by caries (Figure 9.5) and radiographs have shown that there is no pulp involvement or periapical pathology, the carious material should be removed (Figure 9.6 (b)) and a restorative material (Figure 9.6 (c)) is then necessary to line or prepare the cavity with a strong material to protect the pulp. These materials protect the pulp from the restorative materials some of which have been shown to cause pulp inflammation. A permanent restoration is then placed, ensuring a good coronal seal which prevents communication between the dentine and pulp and the oral cavity.

Figure 9.7 [illegible] of the stages in Figure 9.6 after the removal of decay and the smearing of the exposed dentine.

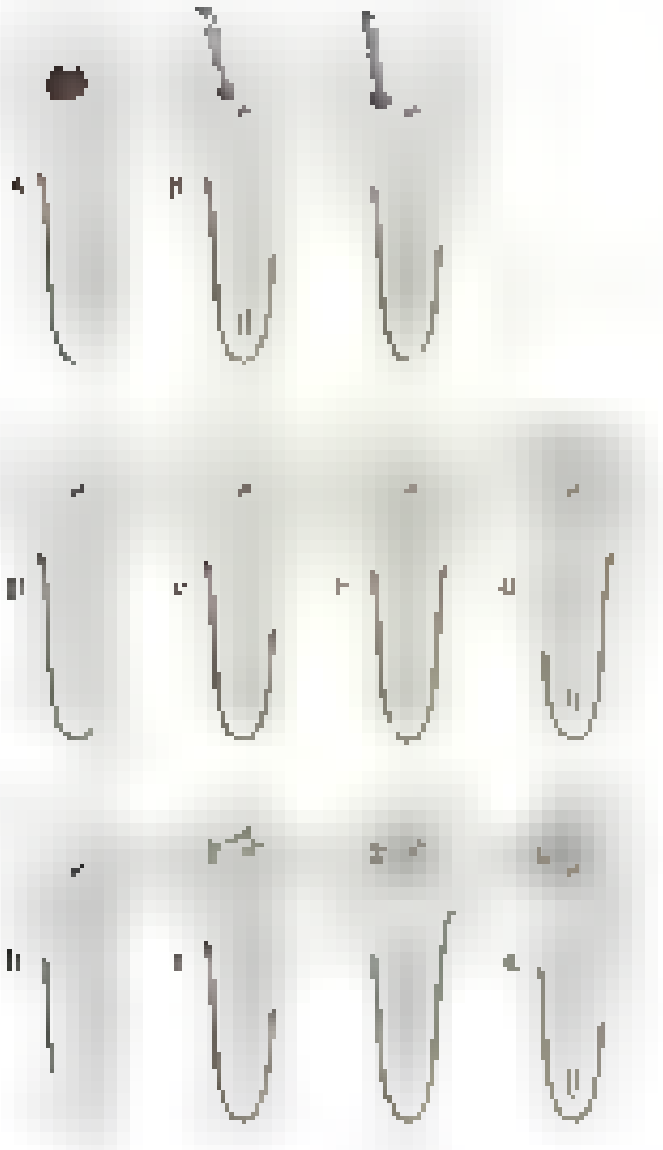


Figure 5.8 Restorational curves

A. Initial lesion in a fissure.

B. A high-speed water-cooled bur is used to remove enamel to reveal the extent of the decay. A slow-speed bur and spoon excavator is used to remove the carious dentine, taking care not to expose the pulp.

C. An underpin is made just short of the proposed gingival margin, so that the enamel is not undermined and that the strength of the restoration is not compromised.

D. A pulp dressing (usually calcium hydroxide paste) is applied to the floor of the cavity to protect the pulp from the restorative material. (Not essential – see text for discussion concerning the extent of this decay.)

E. If composite or compomer restorative material is to be used, a bonding agent is applied to the cavity after it has been conditioned. (Refer to preceding page for manufacturer's instructions.)

F. Light-cured restorative materials should be placed and cured incrementally, so the curing light does not penetrate the full material.

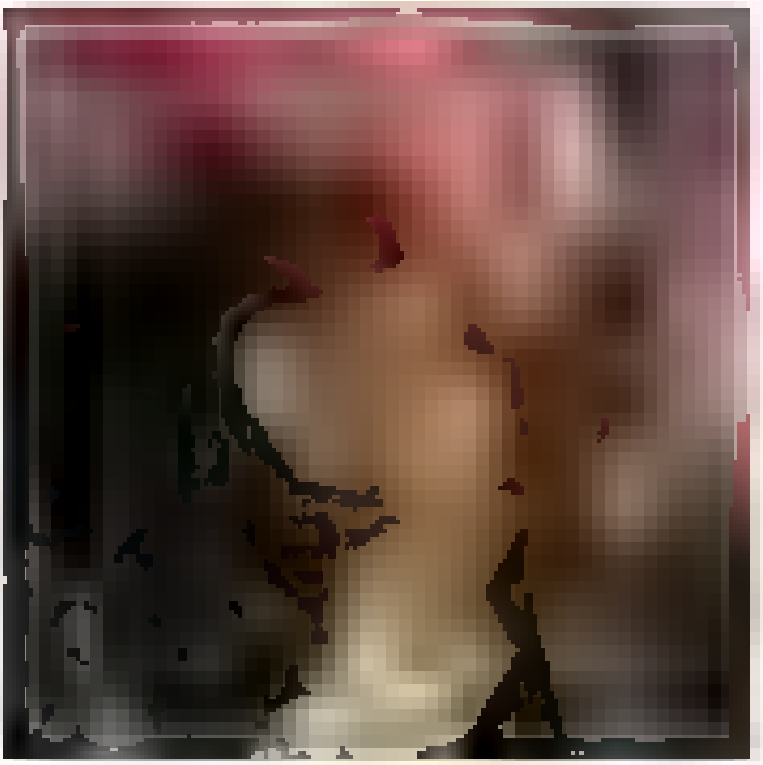
G. The final restoration should be polished and varnished to protect it from degradation and wear.

H. Glass ionomer restoratives may be used as the whole restoration (in this case bonding agent is not required as the ionomer forms a chemical bond with the tooth structure).

When the glass ionomer has hardened, the exposed dentine and enamel should be conditioned, etched and primed.

The bonding agent should then be applied as in E.

I. The final restoration is polished and varnished, as in G.



When amalgam (silver, mercury and copper alloy) was used, particles of the silicone dentures. It was necessary [illegible] to check whether the walls of the cavity were [illegible] to see if [illegible] had taken place physically. [illegible] The amalgam

Figure 5. [illegible] restoration [illegible] and remodeled with an amalgam filling. A piece of tooth material [illegible] that the tooth was [illegible] and damaged by [illegible] during [illegible] preparation.

was polished and then coated with a bonding agent which improved the amalgam underwent [illegible]. However, the procedure by which filled the porcelain space between the restoration and the surface enamel. Modern amalgams are now placed with a bonding material which helps keep the restoration in place and improves the overall [illegible], negating the need for undercuts in the cavity preparation. Amalgam is rarely used in dental restorations.

With the advent of modern resin-type tooth-colored restorative materials it is no longer necessary to create undercuts in the tooth structure in order to mechanically lock the restorative substance to the tooth. Instead, a bonding agent is first applied to the tooth and the restorative material is actually bonded to the bonding agent on a molecular level. A micro-mechanical bond is created when the enamel is etched and dentin conditioned. Etching and conditioning allow the resin composite material to flow into the microscopic irregularities created by the etching process, thereby creating a micro-mechanical bond. Both light- and chemical-cured resin materials are used.

Etching is performed by applying 37% phosphoric acid gel to the enamel surface for 30 seconds to demineralize the enamel and thereby increase the surface area to which bonding agents are applied. A conditioner is used to create similar conditions in dentin. These materials must be thoroughly rinsed off and the tooth surface must then be carefully dried. Overdrying [illegible] the tooth surface, causing etching and conditioning to demineralize [illegible] enamel and dentin materials to the point of collapse. Overdrying will also [illegible] the bonding agent's ability to bond to the tooth structure. Overwetting etching and conditioning will dilute the chemical bonds. A bonding agent is then placed and light-cured. Once placed and cured, glass ionomer restorations should be sealed using a varnish to prevent dissolution of substances [illegible] that can affect the longevity of the restoration.

Figure 9.12 The long endodontic crown with apical periodontitis and partial pulpectomy are indications of treatment for mandibular canine. Crown lengthening surgery is planned to gain adequate tooth structure for restoration. Note the distance between the tooth and alveolar bone. Also, the tooth is short clinically and has a short root length. Note the proximity of the mandibular canal to the root apex in the radiograph. The tooth is isolated using rubber dam. Access cavity is prepared. Working length is determined using an apex locator and confirmed radiographically. Biomechanical preparation is done using rotary files. Calcium hydroxide dressing is placed in the canal and sealed with temporary restoration. The patient is recalled after 1 week. Obturation is done using lateral condensation technique. Post space is prepared using peeso reamers. Fiber post is cemented using dual cure resin cement. Core build up is done using composite resin. Crown preparation is done and impression is made. Provisional crown is cemented. Patient is recalled after 1 week for cementation of permanent crown. Radiograph is taken to confirm the complete cementation of crown. Occlusion is checked and adjusted in centric and eccentric movements. Patient is recalled after 6 months for clinical and radiographic evaluation. Note the periapical healing and bone formation in the mandibular canine. Also, note the bone loss around the mandibular first molar.

Components are incorporated comprising particles and resin which require a bonding agent to transform some of the loose surface.

Components are bonded between composite and gutta-percha often used as necessary additions in the root canal where space is widened.

Advantages of modified stress free concept to create undercuts retain maximum tooth structure, an undercut is the depth of the canal preparation is desirable to add a conservative retention called bonding pockets (Figure 9.12). Care must be exercised when making these undercuts to ensure that the undercuts do not undermine the enamel or weaken the root. Ideally, the depth of the cavity should be that and the junction with the walls curved so as to prevent stripping of the wall during the obturation. The enamel surface should be prepared lightly to increase the surface area which bonding occurs.

Retentions should be established mechanically. A retainer can also be applied improve surface conditions so it makes the restorative material less prone retention thereby reducing gingival inflammation.

Light cured composite materials polymerize as a result of initiation of a light source of specific wavelength. The curing light source generally between 400 and 500 nm and therefore these restorations must be placed and cured incrementally (i.e. in layers) (Figure 9.13). This not only ensures a thorough cured restoration but also reduces post-curing dimensional changes such as restorative shrinkage. The advantages of light-cured composites is that they can be placed and shaped prior to curing. polymerization. The use of a bonding agent ensures the composite surface will lead to an improved marginal restoration which may occur during.

The mechanical RCT have must be removed. Endodontic and restorative advancements made prior to the patient being evaluated. Periodontally affected

Further reading

Craig, R. [illegible] Powers, J. M. and Wataha, J. C. 2020. Dental Materials: Properties and Manipulation. [illegible] Mosby [illegible] ISBN [illegible]

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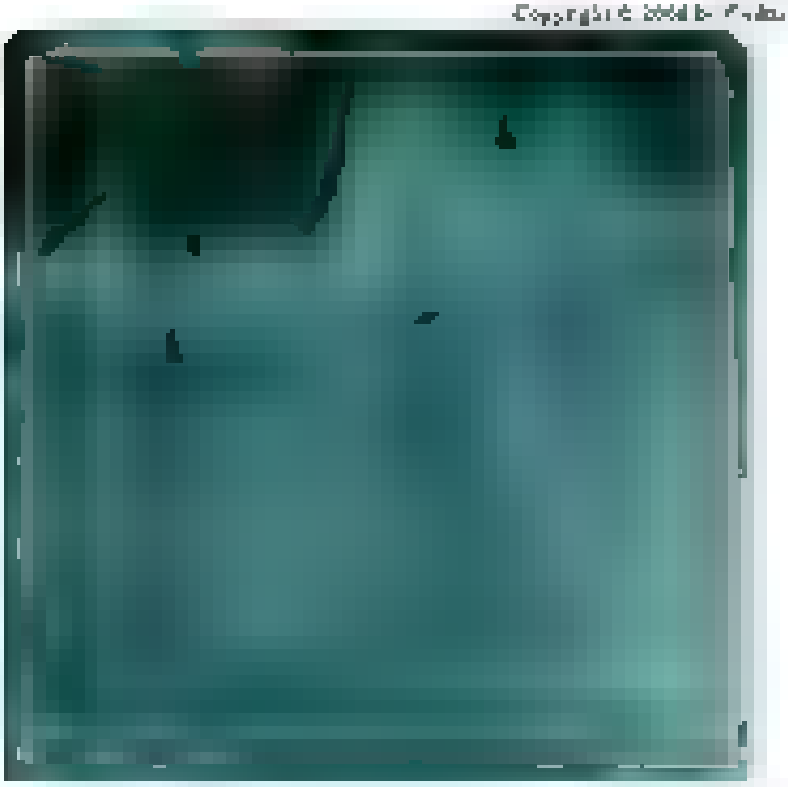


Figure 10: Mandibular molar radiograph showing pulp chamber and root canal

Endodontic therapy is the treatment of the endodontic system and is the purpose of this text. A brief review of normal and complex pulp-dentin-root canal therapy and endodontic success outcomes will be given. These procedures are usually undertaken by clinicians who own the necessary equipment, practical knowledge and expertise to perform specialized treatment-based procedures.

The endodontic system includes the pulp chamber and pulp canal or root canal. Both structures are continuous and of multi-rooted teeth there are projections of pulp tissue called pulp horns (Figure 10). These structures are described as a greater or lesser canal depending upon the needs, e.g. the pulp horns of the crown of the mandibular canal. teeth are well developed and in a relatively short pulp chamber may be an expected as complications in endodontics.

The pulp vessels and blood and lymph vessels nerves and branches direct canal and root canal measured accordingly. The pulp communicates with the periodontal tissues via apical delta and accessory or lateral canals.

The pulp may become calcified as a consequence of various including ageing. Such changes in the teeth, pulp chamber and complicated canal treatment, making subsequent endodontic treatment difficult. Pulp stones, or dentinal calcifications, may be free lying in the pulp tissue or attached to the dentinal walls. Diffuse calcifications are irregular deposits of dentin-like material throughout the pulp tissue. Pulp stones may be found in the pulp chamber or root canal. Pulp stones may be found in the pulp chamber or root canal.

Pulp canal obliteration is a process in which the pulp chamber and root canal are filled with dentin-like material. This process is also known as pulp canal obliteration. It is a common finding in traumatized teeth and in teeth with deep caries. The process is also known as pulp canal obliteration. It is a common finding in traumatized teeth and in teeth with deep caries.

Pulp canal obliteration is a process in which the pulp chamber and root canal are filled with dentin-like material. This process is also known as pulp canal obliteration. It is a common finding in traumatized teeth and in teeth with deep caries. The process is also known as pulp canal obliteration. It is a common finding in traumatized teeth and in teeth with deep caries.

accessible and periapical radiographs usually reveal intact periodontal tissues, an indication that the apical pulp is still vitalic (Figure [illegible]). Endodontic treatment of the involved tooth is recommended and the apical pulp must be monitored by regular periapical radiographic evaluation (Figures [illegible] and [illegible]).

Figure 10.2 The intraoral periapical radiograph of the patient in Figure 10.1 was taken to investigate the cause of pain and swelling. It revealed an extensive periapical radiolucency associated with the mandibular left first molar. The tooth was diagnosed with pulp necrosis and chronic apical periodontitis.

Figure 10.3 Intraoral radiograph taken 6 months after endodontic treatment of the tooth in Figure 10.2 revealed complete healing of the periapical pathology, indicating that the apical periodontium had returned to health.

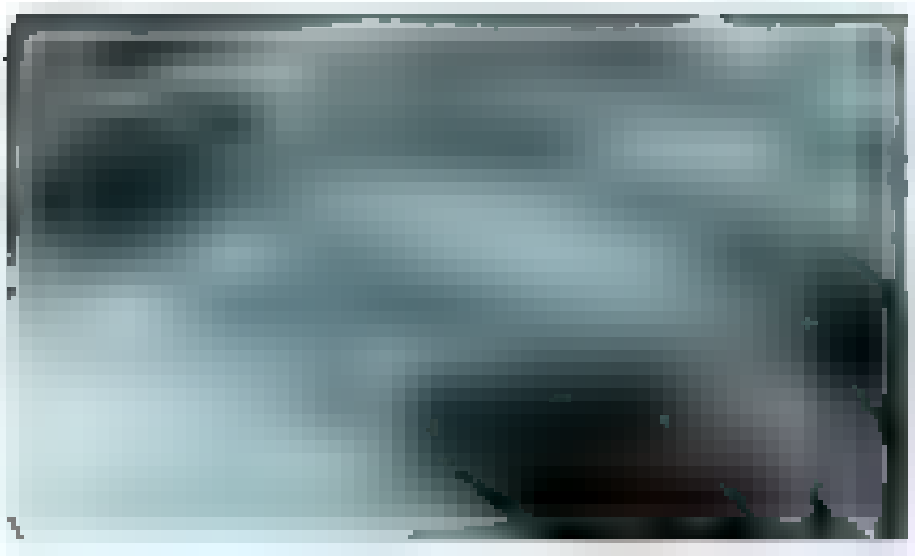


Figure 18.4 Working length is established by inserting a file into the canal from the point at which it should apply, as determined by the preoperative radiograph, and then withdrawing it until the tip can be seen through the open apex. At this point the file tip is just below the dentinal margin.

Figure 18.5 Post-operative radiographs showing the completed treatment. Follow-up radiographs should be recorded at three and six months' post treatment.

Partial pulpectomy

Partial pulpectomy and obturation should not be undertaken by inexperienced clinicians as the procedure can be challenging. Failure at the hands of experienced enthusiasts abounds. It must also be stated that partial endodontic treatment is an inappropriate procedure to undertake with mature teeth. Apexogenesis is complex. Exceptions to this rule are when the procedure is undertaken as a time-limited measure in the management of, for example, patients with immature permanent incisors where prolonged apexification is undesirable. If the patient can make the apexogenesis is complex, the procedure is carried out in complete pulpectomy followed by root-canal therapy. Apexogenesis is the normal treatment of the apical third. When apexogenesis is complete the root will have attained its final length.

Periodically the clinician may elect to perform a pulpectomy procedure as the treatment of patients with underdeveloped roots. During this procedure the coronal pulp tissue is removed at the desired length (usually at the height of the cervical constriction) and a partial pulpectomy is performed when

Figure 10.6 Radiograph showing the final restoration and occlusal appearance during a pulpotomy procedure, which both maintains the tooth's crown and partial pulp tissue and restores it

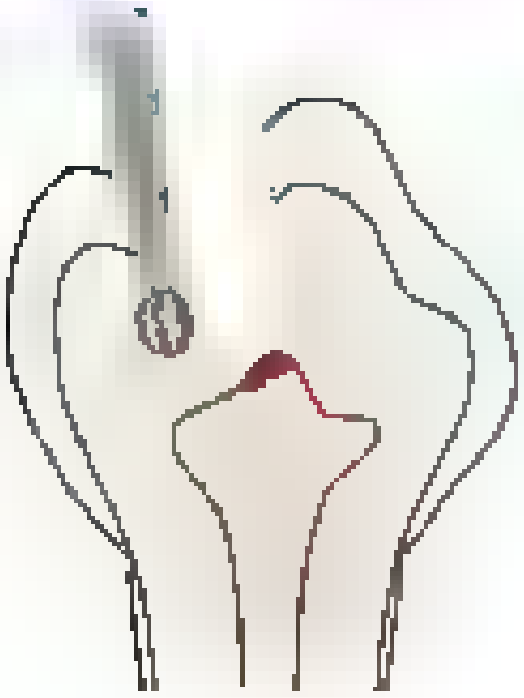


Figure 10.7 Illustrating the location of an amalgam "plug" placed during the pulpotomy procedure prior to restoration

about 3 mm to remove pulp tissue. This is done using a new, sterile bur and diamond bur. The bur is then removed to ensure a solution to control bleeding is now present. Blood vessels in pulp tissue are being constricted by the pulp. A calcium hydroxide dressing is applied to the access site to ensure that the cavity is completely sealed. Access is restored using the clinician's restorative material of choice (Figure 10.6). When preparing the cavity, the restoration is usually undercut (Figure 10.7) to ensure a key that

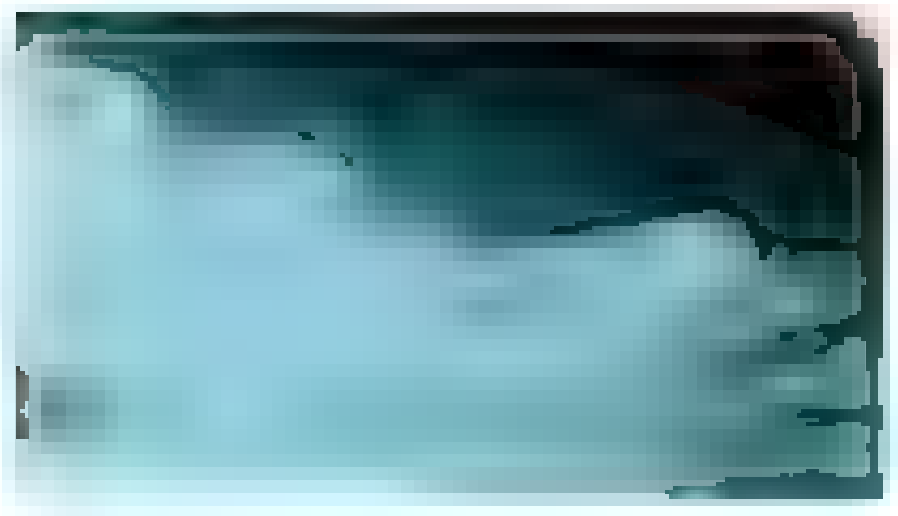


Figure 19.5 Associated treatment outcome – confirmed by complete apexogenesis and a dentinal bridge (proud of the restoration)

Root canal therapy

Steps in root canal therapy

- [illegible] the pulp chamber [illegible] This may be [illegible] Pulpitis [illegible]
- extirpate the pulp using barbed broaches and Hedstrom files

  probe to find the canal orifices and explore and clean the canals. Determine the working length radiographically for each canal and file

  shape and clean the root canal system essential fluids (hypochlorite) with the irrigant. Hand files and Hedstrom files are used for this

  Dry the canal after cleaning with sterile absorbent paper points or medicated cytotoxic solution [illegible] solution at about 60 °C

  When the final file is up to the working length, the apex when carried into the canal should be gently touched [illegible] the apex and be observed on the master file

  Each root canal is irrigated with sodium hypochlorite. Finally, the canal is dried with sterile paper points

  [illegible] the master cone (guttapercha) to the working length radiograph to confirm adequate [illegible] of root canal

  [illegible] cement and apical root canal sealer is used to seal

  [illegible] master cone [illegible] to the apex using a condenser to create [illegible] condensation

  [illegible] cones are used to pack around the master cone until [illegible] is completely obturated (filled in all directions). A spreader can be used to create space for additional accessory cones

  when the root canal procedure is completed, obturation is confirmed by a radiograph. The gutta-percha is trimmed and a base is applied

  final restoration [illegible] using the coronal restorative materials as [illegible] as indicated [illegible] this procedure

  final radiograph taken to confirm complete apical and coronal seal

  follow up radiographs are scheduled annually

Root canal therapy procedure

The procedure requires anaesthesia [illegible] the pulp and extirpation of the pulp tissue using an intracanal instrument and irrigation

[illegible] necessary [illegible] the pulp chamber has been gained, the pulp is removed using a combination of root canal files and barbed broaches. In some instances a second access is created to facilitate a straight line access to the root apex, requiring an access [illegible] be created on the pulp chamber floor coronal to the gingiva. Once the pulp is removed, the walls of the root canal and pulp chamber are cleaned and shaped to accommodate the root filling material, usually GP points made [illegible] rubber and a resilient paste. Once obturation is completed the access cavity is restored

Figure 10.8 A set of Hedstrom files ranging from [illegible] to [illegible], each with rubber stop used to mark working length on the file.

Two commonly used root canal filing instruments are:

- K-files: manufactured from a triangular or rectangular tapered rod which is twisted to create flutes. These instruments operate in a watch-winding fashion, a reverse turning motion created by rolling the instrument handle backwards and forwards between the thumb and forefinger.
- Hedstrom files: are machined from a conical blank with the cutting edge of the file facing up the shaft. These files have their effect on the pull stroke and are inserted into the canal and pulled out to clean and shape the walls. The pulling action shaves material off the canal walls, cleaning and shaping the canal.

Files are manufactured in a number of lengths: 25 mm are adequate for most dog incisors and premolars and cat teeth; 5[illegible] mm files are used for canines [illegible]. Files come in standard sizes from ISO 8 to [illegible]. A file with an ISO size of 25 will have a tip diameter of [illegible] mm (Figure 10.9).

The working length is determined by introducing a file into the root canal and taking a periapical radiograph confirming that the file tip is at the apical extremity of the root canal. Once the working length is determined, all files are measured and marked accordingly (Figure 10.[illegible]) and the canal is then irrigated, debrided and shaped using sequentially larger files until the file, which is the next size up, does not go all the way to the measured working length when inserted into the canal. This file should be gently worked down until it reaches the working length; it then becomes known as the master file. By this time all dentinal shavings produced by the files should be clean [illegible] white or ivory coloured, not grey or black.

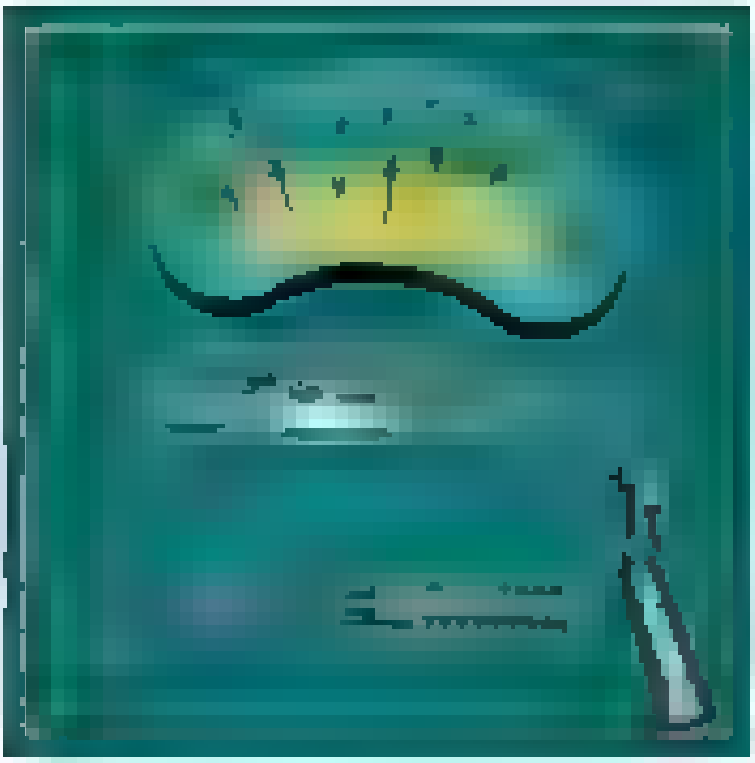


Figure 10.38 [illegible] and map measurement apparatus. A rubber stop is used to measure the file working length. A barbed broach is used to remove the pulp. Endodontic reaming needles are used to both file canal and remove debris. A variable taper file is used to shape the canal. Sodium hypochlorite irrigant is used to irrigate the canal during filing procedures. A variable taper file is used to shape the canal.

The pulp chamber and root canal must be flushed with copious volumes of sodium hypochlorite (unbuffered) at a temperature preferably at 60 °C. Ensuring that surrounding soft tissues are protected from this substance. Flushing should be performed following each filing episode to remove debris and necrotic material and to disinfect the canal. The hypochlorite also acts as a lubricant. The last file can compact residual debris into the apical part of the canal and therefore it is necessary to recapitulate (revert to a smaller size file) regularly to remove filing debris from the apical part of the canal.

Ideally uncontaminated the canal will have been filled to a tapered void with its base at the pulp chamber and the apex corresponding with the apical extent of the root canal. The canal would be dried using paper points using sodium hypochlorite and then rinsed thoroughly using sterile water. Following rinsing the canal should be dried using paper points. Root canal dressings prevent the dimensional paper points from drying out the canal debrided to a corresponding light and assist the irrigation. Some paper points are supplied sterile and others packaged but not sterile and no longer sterile.

Root determination and shaping are complete, the master point (the last point corresponding to the master file (Figure 10.39)) is selected and placed into the canal. A radiograph is taken to ensure that the point is seated all the way to the apical terminus of the root canal. When this can be confirmed, the file point is removed, and a small amount of sealant is applied to the walls of the canal and the master point is inserted all the way to the apex. It was demonstrated that instruments used to make all root canal preparations should be used to clean the master point into the apical terminal constriction. If there are small narrowing the master point, especially a curvature may be encountered consume the master point laterally, creating space for accessory points to be

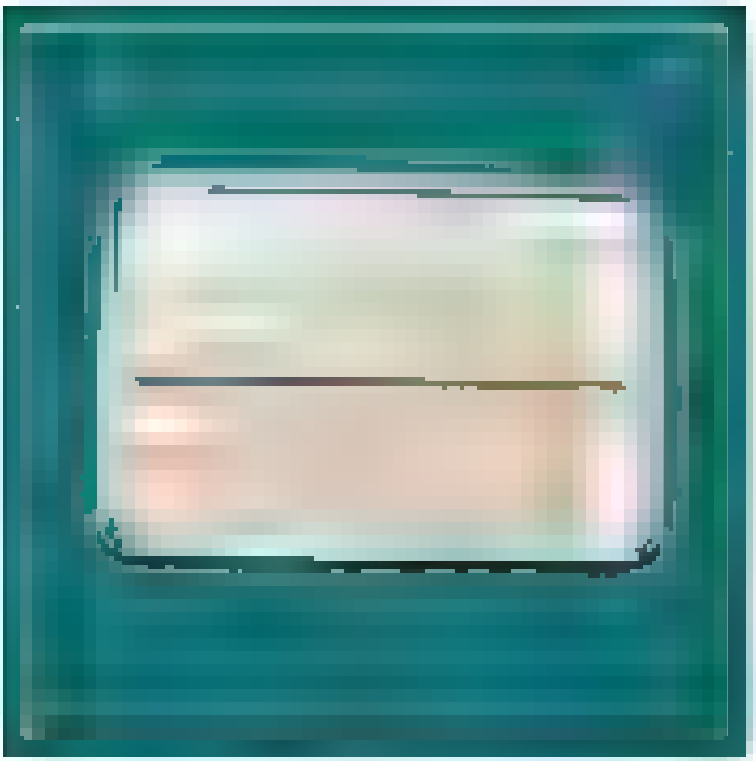
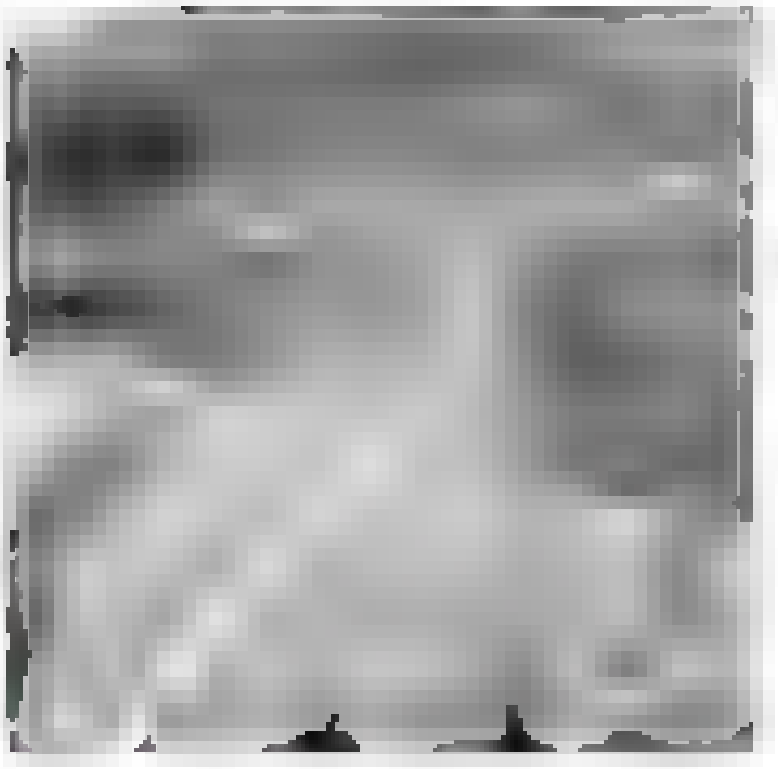


Figure 10-11 Pulpal pockets are
[illegible]

Figure 10-12 Some [illegible]

restored could be which causes a chronic [illegible]. After endodontic [illegible] the chronic [illegible] gutta-percha is removed and a base [illegible] the gutta-percha prior to placement [illegible] (See Chapter 9). Biomechanical [illegible] has been created it must be restored in the same way as previously described. A final radiograph should be taken to confirm good coronal and apical seals (Figure 10-13).

If post-op radiographs [illegible] are not available following the procedure, [illegible] carefully, each canal is judged as being successful or not based on [illegible] the periapical [illegible] around the apex [illegible]. Histological [illegible] of success or [illegible] are possible only by [illegible]



Horizontal resorption

Also known as cupping, this is a rare form of resorption that usually occurs as a result of trauma to the tooth. The resorption process is usually self-limiting and the pulp is rarely exposed.

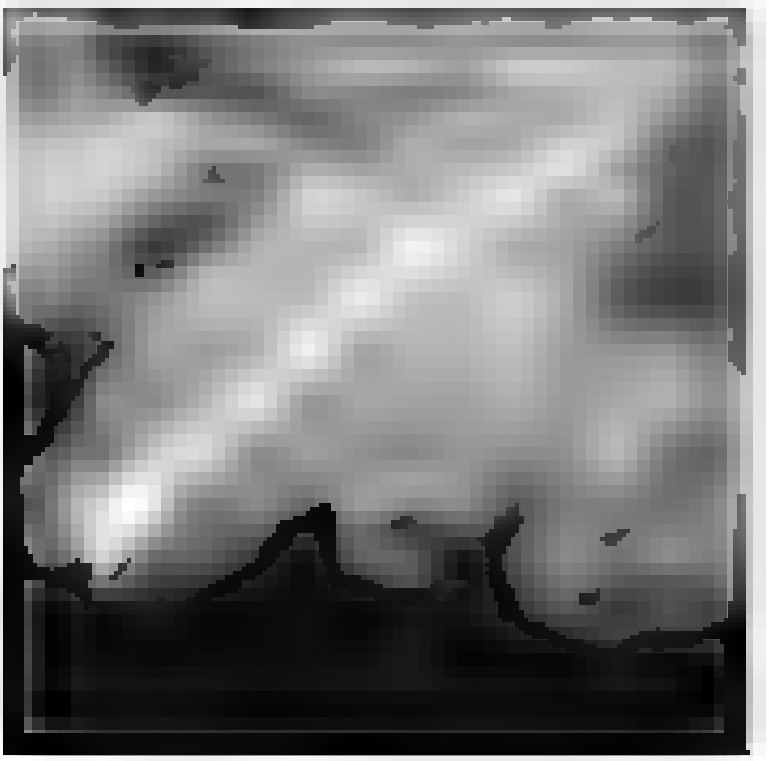


Figure 16.13 Silicification in a sample with a good apical [illegible]

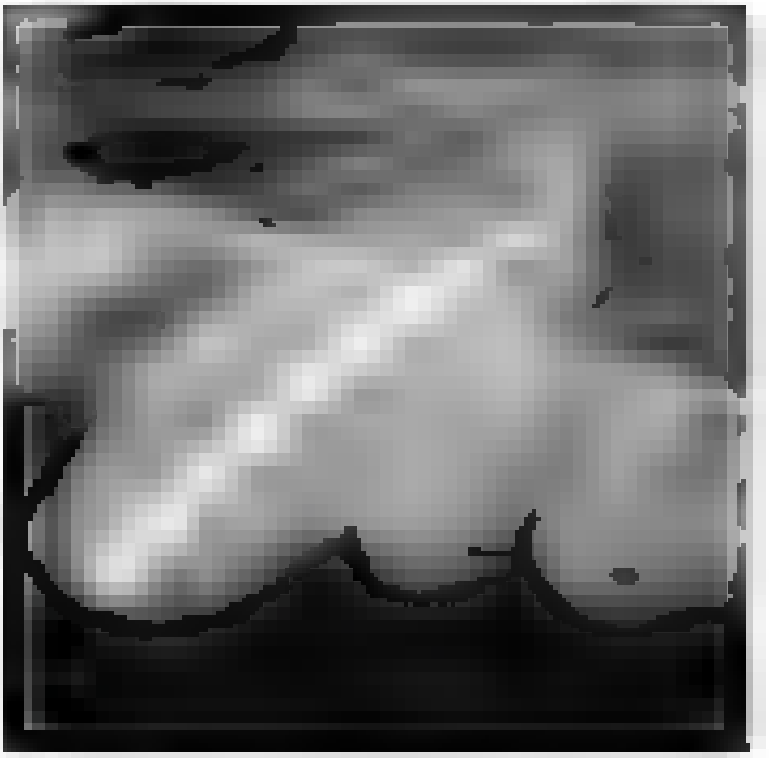


Figure 16.14 Final exfoliation showing a good conceptacle. The tightly radiolaced area between the containing material and the central [illegible] which is not radiolaced

that sequentially filled and discrete at the apical extremity. These changes created a cavity called which is separated from the crown of the apex containing more reflective flattening and also darkened as material being flushed through the apical canal. Characteristic of the [illegible] available to the prepared cross

Some electric drivers are equipped with a torque control which stops the driver once a preset friction is reached and reverses the instrument automatically before fracturing. This reduces the incidence of instrument separation/breakage.

Ultrasonic endodontics

Some ultrasonic dental scaler units have specially designed endodontic files used to debride and shape canals. An advantage of these systems is that the flushing fluid is delivered through the tip, ensuring that the entire canal is flushed continuously during instrumentation.

Thermoplastic obturation

Numerous 'heated' gutta percha systems are available. Some heat the gutta percha in a syringe and the canal is subsequently filled with molten material. Other systems have gutta percha applied to carriers manufactured to ISO dimensions and heated in specially designed ovens. Once the material has been heated for the appropriate length of time, the gutta percha is placed in the canal using the carrier, which remains in situ. Excess material is trimmed off prior to the final restoration being placed.

Some interesting cases

The cat in Figure 10.32 was involved in a road traffic accident and sustained fractures to both maxillary canines. Although these teeth are good candidates for endodontic therapy, a pre-treatment radiograph revealed that one of the

Figure 10.32: Cat with bilateral canine fractures as a result of a road traffic accident. Pre-treatment radiographs revealed that one canine had a vertical fracture of the root, necessitating extraction. The other canine underwent root canal therapy.

Figure 10.20 Radiograph showing [illegible] after [illegible] root canal therapy

[illegible] and root canal therapy was performed on this tooth. When important tooth structure and materials are extracted to access a necrotic tooth, it must be remembered that these do not cause [illegible] to appear thinner. In Figure 10.20 the mandibular right molar [illegible] to the palatal aspect. By advancing the crown radiograph to assess our case lesions, the pulp chamber may be breached at one of the pulp horns. Radiographs to determine the incisal extent of the pulp horns is essential. In the event that the pulp horns caused will case the crowns, amputation of the acquired [illegible] demineralised [illegible] by root canal therapy.

Further reading

[illegible]

Torabinejad, M. and Walton, R.E. (2009) Endodontics: Principles and Practice. Fourth edition. Saunders Elsevier, Philadelphia.

Whitworth, J. (2002) Endodontics. Blackwell Science, Oxford.

When considering [illegible] dental [illegible] [illegible] with [illegible] still [illegible] observed with a dominant pack leader [illegible] health [illegible] position in the pack.

[illegible] dog with an [illegible] played with [illegible] again. Although [illegible] chewing.

[illegible] suffering from severe periodontal disease and those that have [illegible] pain. The [illegible] Whilst holding [illegible] deep palatal [illegible]

Let us assume that [illegible] patients experience pain [illegible] and help them by relieving the pain [illegible]

[illegible] whether [illegible] periodontal treatment [illegible] all result in varying degrees of pain. We need to manage this in such a way that we keep [illegible] comfortable.

There are two sources of pain associated with dental surgery, namely acute pain associated with tissue damage such as surgery and [illegible] associated with inflammation. [illegible] pain [illegible] Sharp [illegible] fibres [illegible] responsible for pain conduction.

[illegible] nerve fibres [illegible] the greater the [illegible] the greater the number of action potentials and the longer the duration of the stimulus the longer the train of action potentials.

Pre-emptive pain management ensures that pain impulses [illegible] leading to [illegible] the wind-up phenomenon, and a more comfortable patient in the post-operative period.

[illegible] prophylaxis may [illegible] mild pain, while extractions [illegible] moderate to severe pain.

The use of multiple analgesics which have different actions has been [illegible] pain [illegible]

There are four main analgesic groups

- Opioids
- Non-steroidal anti-inflammatory drugs (NSAIDs)
- [illegible] agonists
- Local anaesthetics

[illegible] local anaesthetic infusion may be [illegible] analgesia

Opioids

Opioids relieve pain by binding with peripheral and central opioid receptors. Morphine is the reference standard for strong non-receptor agonists. Pethidine is shorter and broader than morphine but has a short-lived effect and must be delivered by continuous infusion or intravenous bolus. Morphine injections should be repeated at more frequent intervals. Buprenorphine is a partial opioid agonist and is also an effective non-receptor blocker which is reported as safe in moderate-severity overdose. These drugs can be used pre-, intra- and post-operatively.

Non-steroidal anti-inflammatory drugs (NSAIDs)

Diclofenac and meloxicam are the two NSAIDs which can be administered intravenously. They are given to dogs undergoing dentistry and orthopaedic procedures. Diclofenac can be given orally as a single dose of 1 mg/kg. Meloxicam is given orally as a single dose of 0.2 mg/kg. Both drugs are given at the beginning of the procedure.

Local anaesthetics and regional anaesthetic blocks

Local anaesthetic drugs (LAs) have a high pKa (pH at which they are 50% ionised) of approximately 8.0, which means that at physiological pH (7.4) most of the drug is in the ionised form. The ionised drug is water soluble and has the ability to penetrate the cell membrane and block the sodium channels.

Factors affecting the onset of action of LAs include the pKa of the drug and the concentration of the drug at the target site. The lower the pKa, the faster the onset of action.

Duration of action of local anaesthetic drugs is determined by the following:

- Rate of uptake into the systemic circulation
- Rate of metabolism
- Rate of excretion

Where Stiff is the concentration of the drug at the site of action, Cb is the concentration of the unchanged drug remaining in the blood, and Vd is the volume of distribution.

Duration of action of LAs is also affected by the presence of vasoconstrictors. There will be vasodilation at the site of the injection of LAs. This will result in the drug being absorbed more rapidly into the systemic circulation. In order to prolong the duration of action of LAs, vasoconstrictors are added to the drug. The vasoconstrictor causes local vasoconstriction, which slows the absorption of the drug into the systemic circulation. This results in a longer duration of action of the LA. Vasoconstrictors also help to reduce the risk of toxicity by slowing the absorption of the drug into the systemic circulation. The vasoconstrictor also helps to reduce the risk of toxicity by slowing the absorption of the drug into the systemic circulation.

Table 1 lists the local anaesthetic agents commonly used in veterinary dentistry and surgery, providing the local anaesthetic agents which contain

Local anesthetic	Dosage (total dose mg/kg body mass)	Onset of activity	Duration of activity (minutes)
Procaine	7.0	Slow	30–60
Bupivacaine	3	Intermediate	180–360
Ropivacaine	3	Intermediate	180–360
Lidocaine	4.5	Intermediate	60–120

Table 9.1 Local anesthetic agents

vasoconstrictor agents to reduce tissue blood flow and increase local anesthetic agent uptake into the circulation.

The injection sites of local and regional anesthetic blocks commonly used in veterinary dentistry are shown in Figure 9.1. Table 9.2 lists the local anesthetic(s) and technique(s) recommended for each injection.

Figure 9.1 Dental regional anesthetic injection sites.
Table 9.2 Local anesthetic and regional anesthetic blocks.
A: Supraorbital mental block.
B: Deep mental block.
C: Inferior alveolar nerve block: intraoral approach.
D: Alveolar gingival mental block: percutaneous approach.
E: Supraorbital, infraorbital, deep mental, alveolar nerve, and maxillary block.
F: Maxillary block.

Block	Effect					
	Mental: superficial	Mental: deep	Mandibular	Infraorbital: superficial	Infraorbital: deep	Maxillary
Mandibular canine	Mandibular canine, premolars, mental nerve, lower lip and gingiva	Mandibular canine, premolars, alveolar nerve, lower lip and gingiva	Mandibular canine, premolars, molars, lower lip and soft tissues	Infraorbital nerve, upper lip, gingiva, and mucous membranes to midline	Infraorbital nerve, upper lip, gingiva, and mucous membranes to midline, including PMR	Mandibular canine, premolars, molars, lower lip, gingiva, soft tissues, and ipsilateral maxillary quadrant
Mandibular molar	None	Mandibular canine and premolars	Mandibular premolars, molars, and soft tissues	None	Infraorbital nerve, upper lip, gingiva, and mucous membranes to midline, including PMR	Ipsilateral maxillary quadrant

Table 9.2 Local anesthetic and regional anesthetic blocks

Mandibular Nerve

The supraperiosteal mental block is performed by inserting a long gauge needle (either short beveled or slightly curved) to the lateral mucosa over the canine eminence. The needle is then advanced to the lateral mandibular cortex and advanced until it contacts the periosteum, directing it posteriorly to the middle mental foramen. The tip of the needle is then positioned in close proximity to the mandibular nerve as it exits the mandibular canal through the mental foramen. Aspiration should be performed to prevent intravascular injection. Approximately 1 mL of anesthetic solution is deposited (Figure 10-2).

For the deep mental block, the needle is advanced into the middle mental foramen in a similar fashion. With a finger placed over the foramen, the needle is very slowly injected until the mental nerve becomes blanched after anesthesia. Rapid injection should be avoided to prevent neuropraxia due to pressure within the mental foramen (Figure 10-3).

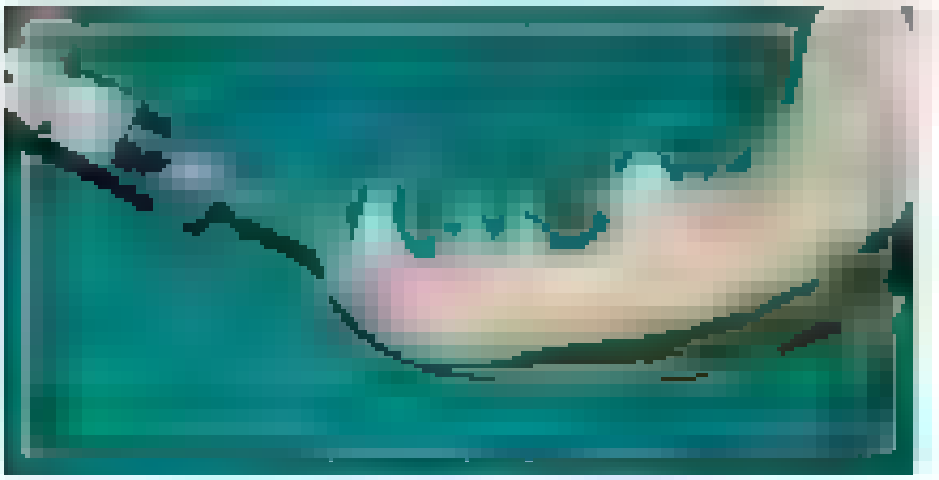


Figure 10-2 The supraperiosteal mental block. The middle mental foramen is located at about the apex of the second premolar. The needle is advanced to the point from which the mental nerve exits the mandibular canal after aspiration to prevent the needle from entering the mandibular canal.

Figure 10-3 The deep mental block is produced in a similar fashion to the supraperiosteal mental block. The needle is advanced from the mental aspect and inserted into the middle mental foramen. After aspiration to prevent intravascular injection, the solution is injected slowly to prevent neuropraxia as the mental nerve is visible in the mandibular canal.

Figure 11-3 The mylohyoid bridge. Intraoral approach: the neurovascular bundle can be palpated intraorally by sliding a finger along the medial aspect of the mandible running between the temporalis tendon and the angular process to where it enters the mandibular foramen. The needle is advanced submucosally until it reaches the mandibular foramen and then angled slightly posteriorly. Gentle finger pressure over the needle will help reduce the discomfort due to the block.

Mandibular block

The mandibular block can be administered extraorally or intraorally. Using either technique, the neurovascular bundle is targeted as it enters the mandibular foramen, which is located lingually, above and midway between the mandibular occlusal plane and the coronoid process. When using the extraoral technique, the needle is inserted through the lateral mandibular alveolar mucosa, distal to the mandibular first molar and advanced until it reaches the mandibular foramen (Figures 11-4). The needle penetrates the mandibular and capsular periosteum, but does not penetrate the masseter muscle tendon or coronoid process. The neurovascular bundle is anesthetized prior to the second molar and alveolar bone proximal to the mandibular foramen. Anesthetic solution (Figure 11-5).

Infraorbital block

Digitally identify the infraorbital neurovascular bundle as it exits the infraorbital foramen. Insert the needle through the buccal maxillary alveolar mucosa with the bevel facing the maxilla and advance it until the tip reaches the infraorbital foramen. Aspirate before injecting (Figure 11-6).

The superior alveolar block is performed by advancing the needle into the pterygopalatine canal as shown near the apex of the maxillary first premolar. Digital pressure at the infraorbital foramen will minimize the discomfort due to the injection. Aspirate before injecting (Figure 11-7).

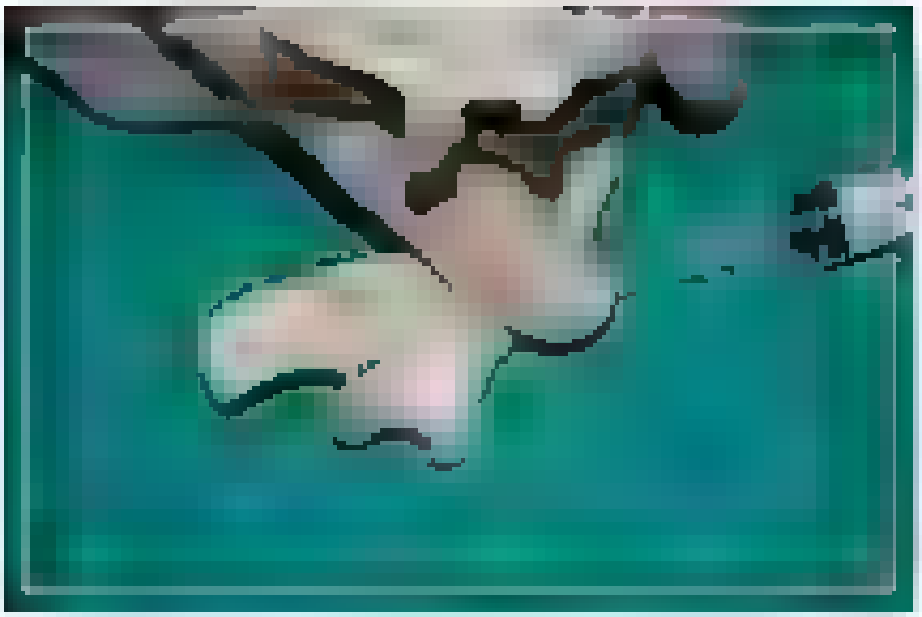


Figure 1. The mandibular block (posterior approach). The neurovascular structures are identified in Figure 2. The needle is inserted medial to the mandibular ramus between the third molar and the angle of the mandible and advanced until it touches the mandibular bone. Reproduced with permission.

Figure 2. Superficial infraorbital block. Identify the infraorbital foramen (IOF) and the nasal alar groove. The needle is inserted 1 cm below the IOF and advanced until it touches the infraorbital bone. Aspirate and inject 1 mL of solution. Massage the area for 5 minutes to facilitate the anesthetic.

Maxillary Block

The maxillary block may be performed supraperiosteally or percutaneously. Performing the intraoral palatal technique is advanced once the infraorbital nerve at the level of the maxillary molar (Figure 3). Digital pressure is applied over the infraorbital foramen and pressure is maintained above. The needle is then inserted parallel to the maxillary molar and advanced over the maxillary foramen.

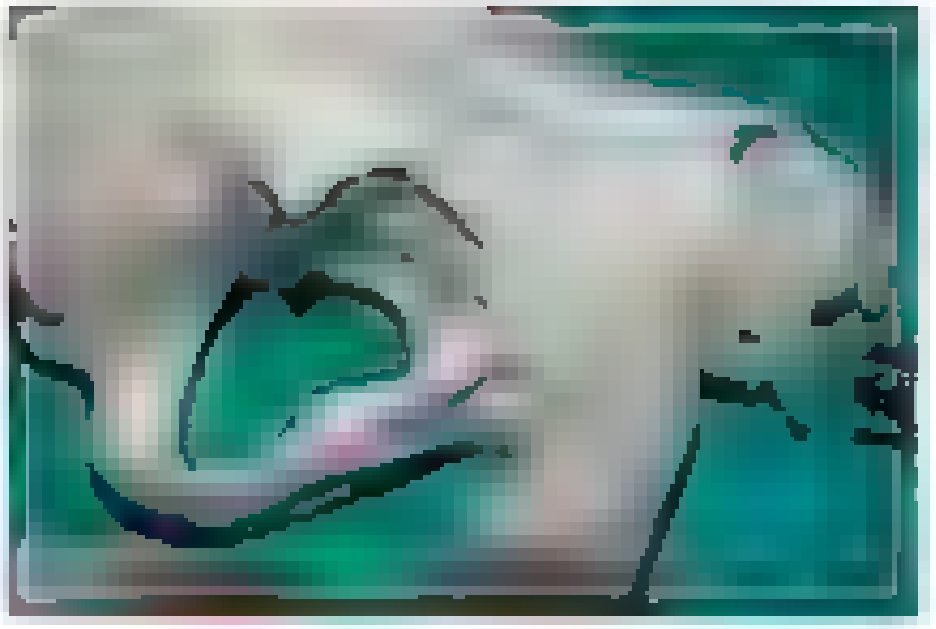


Figure 11.7 The deep retro-orbital block. Proceed as in Figure 11.6, insert the needle over the retro-orbital canal and aspirate. If no blood return, inject 4 ml of the mixture. Allow time for anesthesia to develop. Repeat injection as necessary.

Figure 11.8 The maxillary block. Proceed as in Figure 11.6, but advance the needle to the level of maxillary nerve. Apply digital pressure and aspirate and inject as before.

When using the percutaneous route, the needle is directed at the angle formed by the zygomatic arch and the medial canthus just medial to maxillary molar 2. The needle should be advanced at a retro-orbital direction aiming at the caudal opening of the retro-orbital canal (pterygopalatine foramen). (Read as Tevere capsule) (Figure 11.9). Aspirate and inject as previously described.

Figure 8.8 The mandible bone generally moves upwards (the condyle is inverted on the image) to close the jaw and the teeth typically pull inwards. If mandible movement and subsequent transverse-plane direction sensing in the medial meaning of the mid-coronal canal (mandible movement, right) is recorded, sensation is directed from an anterior appearance (meaning the teeth pull medial to it). Mandibular motion and proceeding as described

Further reading

Cortical Structure ... (2011) Microscopic Anatomical Benchmarks Taxonomic. Biological Inc.

Gaynor, ... and Allen III, W. W. ... (2002) Handbook of Performance from Anatomical Models for Medical Students.

Figure 12. Brachycephalic dogs have short muzzles and may require assistance with breathing.

Normal occlusion for one breed may be considered abnormal for another. For example, the brachycephalic mandibular Boxer dog is considered normal, as is a German shepherd dog and pekingese.

There are three types of malocclusion:

1. Brachycephalic, e.g. Bull dogs, Boxer dogs, Pugs (see Figure 2).
2. Mesocephalic, e.g. German shepherd dogs, border collies, Labrador retrievers (see Figure 2).
3. Dolichocephalic, e.g. greyhounds, rough collies, Shetland sheepdogs, Borzois (see Figure 12).

In brachycephalic breeds the mandibles are slightly narrower and shorter than the maxillae, resulting in what is termed a *parrot mouth*. The mandibular incisors (which are the angles of the maxillary incisors) palatal aspect (the maxillary incisors) (see Figure 2). The mandibular canine teeth are usually between the maxillary lateral incisor and canine teeth in lingual aspect, resulting against the interdental spaces of the diastema between these maxillary teeth (Figure 2). The palatal aspect of the maxillary canine tips against the labial cervical enamel of the mandibular first premolar (Figure 2). The maxillary and mandibular premolars interdigitate with the mandibular premolars being more rostral (Figure 2). The premolars rarely touch with each other.

The rostral and middle aspect of the mandibular incisor 1 occlusal pad to the maxillary carnassial tooth to make up the occlusion-buccal part of the rostral aspect mandibular canine tooth (see Figure 2). The dental aspect mandibular molar 1 occludes with the mesial cusp of the palatal aspect of maxillary molar

Figure 12.6 Procoptodon goliah: skull and mandible with enlarged upper canines

Figure 12.7 Dolichosuchus longiceps: skull and mandible with increased space between premaxillae

Figure 2.5 The cranio-caudal path of mandibular motion includes both the distal path of the palato-occlusal jump of mandibular motion and the mesial path of the palato-occlusal function of masticatory motion (Figure 2.5). The cranio-caudal path of mandibular motion includes both the distal

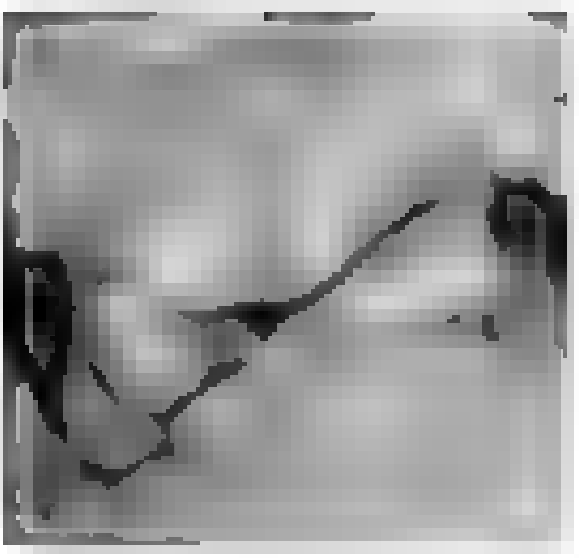


Figure 12.8 Mandibular molar occlusion with maxillary molars. In some animals the buccal cusp of the mandibular molars is

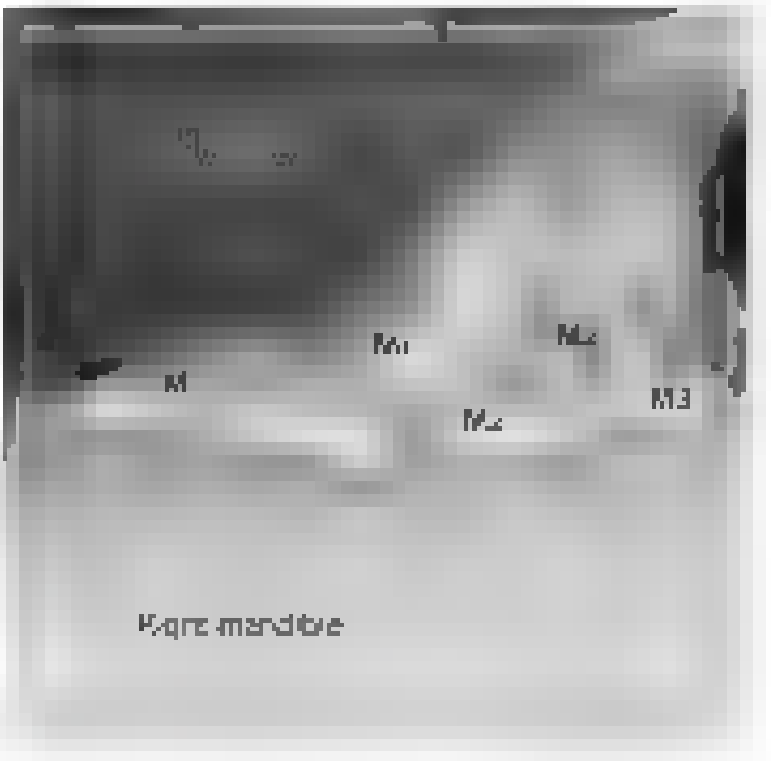


Figure 12.9 The distal edge of mandibular molar occludes against the mesial surface of the next distal tooth. Mandibular M1 occludes against the palatal cusps of maxillary teeth and M2 mandibular M3 occludes against the distal palatal aspect of maxillary M2

palato-occlusal surface of maxillary molars (Figure 12.9). The buccal cusps of maxillary molars meet and partially overlap the mandibular molars (Figure 12.10).

Brachycephalic animals may have a normal scissor bite but often will have either a reverse scissor bite (mandibular incisors caudal to maxillary incisors; mandibular dog in Figure 12.11) or a malocclusion (Figure 12.12) in which maxillary incisors are caudal to mandibular incisors when the mouth is closed.

Figure 12.12(a) Preoperative chest radiograph showing a right pneumothorax

Figure 12.12(b) Chest tube placed for right pneumothorax

a closed thoracostomy procedure is to place a drainage device in the pleural space. Figure 12.13(a) and (b) The procedure may be performed in the emergency department, operating room, or intensive care unit. Figure 12.14 Several factors must be considered when deciding on the most appropriate

Figure 2.63 The mandibular right premolar in plong

Figure 2.64 Short maxillary left premolars are crowded and overlap mesially

and dextrocclusion, but the teeth in the mandibular arcades [illegible] bracket-type braces normally may be arranged in an S-shape (Figure 2.65). Bull dogs often have supernumerary incisors, but because their incisors have a prominence (Figure [illegible]), in some dogs the maxillary canal incisors have col-

Figure 12.15 [illegible]

Figure 12.16 [illegible]

the lingual aspect of the mandibular incisors, causing retraction of both incisors and reduction of overjet and overbite. Figure 12.17 is suggestive of maxillary bone displacement as the mandible develops a normal overbite with the mandibular incisors proclining slightly beyond the maxillary incisors (Figure 12.18 and the upper lip margin

Brachycephalic breeds have large muscles which tend to make them appear. The muscles are usually of normal length but in some cases, especially longer than the mandible causing a maxillary prog. The mandibular muscles can impinge on the palate and cause

Figure 12.14 Dorsiflexion
Metaphysis is enlarged and sometimes so wide that it appears as though there are two epiphyses.

and result in excessive mineralization. Clinically, the abnormal bone ends appear enlarged and can give the appearance of gaps in the skeleton (Figure 12.14).

Commonly seen musculoskeletal signs

It is important to remember that each joint should be evaluated independently of the others and should be actively moved through its full range of motion. Joints should be moved back to normal again as a developmental process. Joints should be moved the muscles grow at the same pace but often growth appears to alternate with that of the muscles which also usually both grow at the same pace.

When checking whether an animal is suffering from a bone lesion one may look for swelling, pain, or abnormal movement. Evaluate the relationship of the pelvis and the vertebrae and the vertebrae and the skull (Figure 12.15). Figure 12.15 shows normal vertebral interdigitations.

Although when a muscle or adjacent tendons are out of alignment the animal is likely to be at a reduced or a compromised condition and there could be adjoining tendons which show signs of contracture (Figure 12.16). This is a normal musculoskeletal. It is important that we can be alignment of tendons is more likely due to a genetic predisposition which is eventually heritable. This is a skeletal musculoskeletal. Others may have muscular skeletal tendons (Figures 12.17 and 12.18) but these only are part of what is called musculoskeletal.

Figure 12.23 Mixed dentition. Angle discrepancies in important relationships between the premaxillary and mandibular dentoalveolar elements. In this case, maxillary and mandibular right central premolars are in lingual occlusion as opposed to a more normal buccal occlusion.

Figure 12.24 Normal premolar interdigitation.

Mandibular prognathism

In this condition, the chin is more than the maxilla, and the maxillary teeth are overlapped by the mandibular teeth. Instances of mandibular prognathism often also manifest pre-gonadism. Persons with mandibular prognathism

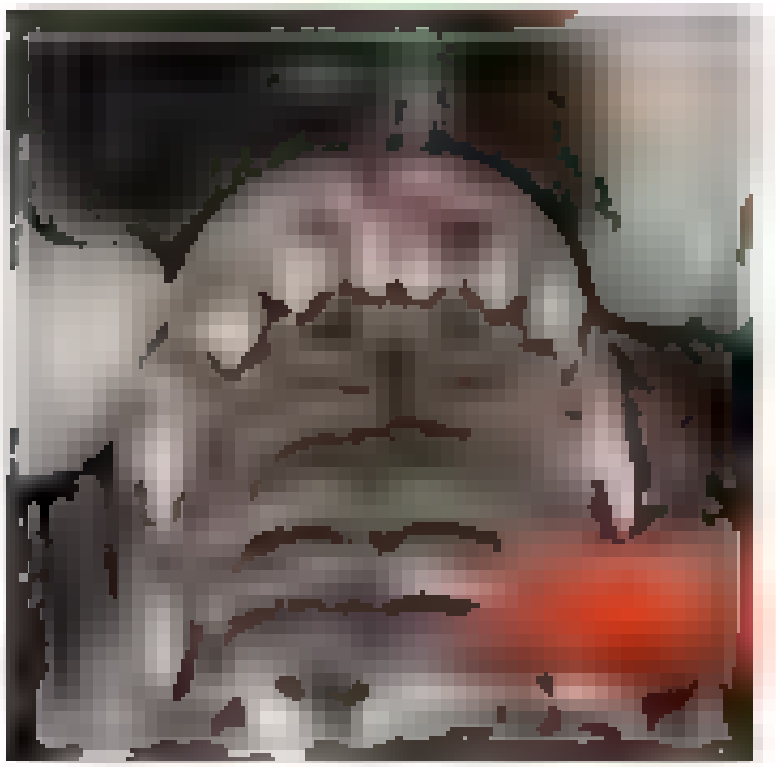
Figure 12.22 (a) Malocclusion attack. [illegible]

Figure 12.22 (b) [illegible]

[illegible]

well represented in English bull terriers. It is uncommon in other breeds and is rare in non-pedigree dogs.

Some breeds, with normal incisor number, have mandibular canines which are more upright than normal and which impinge on the palatal soft



Having suspected endodontic-periodontal pathosis, deep periodontal pockets in the anterior maxillary gingiva (Figure 17-8) and palatal soft tissue swelling, he made a diagnosis of acute periapical abscess with sinus tract formation. These lesions often expose the apex of the tooth and bleed on probing. Periapical radiographs

Figure 17-7 The orbital maxillary soft tissue swelling of the right upper lip. Note that the anterior palatal mucosa is also inflamed and has been compromised by the endodontic-periodontal lesion of the maxillary central incisor. There is an overlap of pressure from the upper lip.

Figure 17-8 Deep periodontal pocket in the anterior palatal mucosa of a patient with acute periapical abscess of the maxillary central incisor. Note the swelling and erythema of the soft tissue around the tooth.

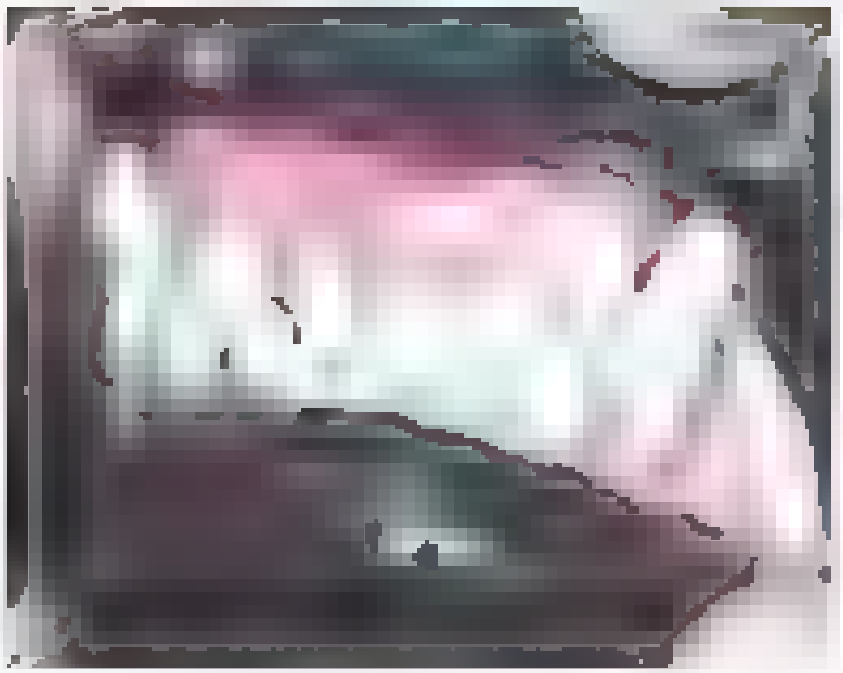
abnormal acquired [illegible] occasion (Figure [illegible]) or congenital. Extensive [illegible] which [illegible] space [illegible] developing [illegible]

Figure 12.33 Another option in the treatment of malocclusion and severe tooth impaction is surgical exposure and orthodontic therapy. Here, teeth were exposed and the cover of the dental crowns giving the enamel a functional and restorable life.

Figure 12.34 Reversible cause. Why may be necessary to maintain adequate hydration?

Reversible cause: Why may be necessary to maintain adequate hydration?

Tooth movement should be carefully monitored with periodic examinations (Figure 12.35) to ensure that the teeth are moving as predicted. Figure 12.36 shows the orthodontic process.



Knowledge check

This document is a molecular which some mandatory uncover are in reverse
screen bill, medical actions are in normal manual volunteer (Figure 8. 46) at
all mandatory accurate maybe in reverse manual bed. It is usually unnecessary

Figure 12 [illegible] the mandibular third premolar is exposing pulpal tissue as the mandibular first premolar

to treat this. Alternatively, there is the option of extraction and composite filling with crown & bridge. Although orthodontic treatment is rarely performed

Dental pathology

This describes the malocclusion where the mandibular premolar and sometimes mandibular molar [illegible] outside normal to the maxillary arch. Figure 2.[illegible] If the animal has a [illegible] and functional bite no treatment is indicated. However if there is discomfort or trauma due to the malocclusion the offending tooth should be extracted. Orthodontics is usually not indicated in these cases. The normal physical cleaning of the mandibular molar teeth by the maxillary premolar does not occur and therefore the mandibular molar accumulates plaque and calculus which will require more regular professional treatment. Owners should be [illegible] able to keep the teeth clean using dental brushes or [illegible]

Why are

This describes the malocclusion resulting from the [illegible] arch is crooked [illegible]. This may be congenital or as a result [illegible] Figure 1.[illegible] It is necessary to check carefully as [illegible] but where they do not exclude [illegible] some dental malocclusions as common this is [illegible] from chewing and interfere with mastication. In these cases the teeth of lower [illegible] should be extracted and correction to create a functional and [illegible] Figure [illegible] is [illegible]

[illegible] unnecessary teeth [illegible] do not cause problems but when they do they should be [illegible] extracted. Radiographs are [illegible] to [illegible] [illegible]

include erosion and pain and inflammation caused by the bone tools and evidence of potential weaponry. The dental findings (Figure 1.40, Table 1.1) are consistent with a diet that does not include processed foods and can therefore be maintained in the wild (Figure 1.40 and 1.41).

Figure 12.69(b) This teeth is also important. Maxillary left lateral incisor is rotated, crossed, crowding the adjacent teeth and has a conical crown and horizontal bite.

Figure 12.69 Supernumerary tooth. Should be radiographed before a diagnosis is made. Supernumeraries may be precocial deciduous teeth, or be polyphyodont (multiple generations of deciduous teeth) in nature.

Figure 12.45 [illegible]

Figure 12.46 [illegible]

Misaligned teeth may be unsightly but if they are not accompanied by crowding problems they should be maintained in the mouth (Figures 12.45 and 12.46).

Some malocclusions are inherited and genetic characteristics like misaligned teeth can be maintained in the mouth (Figures 12.45 and 12.46).

Figure 12.48 The jaw fracture in this mandibular left canine region extends to the maxillary anterior region of the left lateral incisor. The mandibular canine has been moved inferiorly, giving the normal appearance while the mandibular canine should be positioned

Figure 12.49 The patient has a comfortable bite even though the mandibular canine is palatally displaced. The canine was formed in place instead of being moved into position by orthodontic treatment. The patient should be monitored long-term and periodontal or endodontic treatment performed if required

Further reading

[illegible]
[illegible]
[illegible]

Congenital Malformation (Figure 9.3)

Figure 9.3 Congenital malformation
Coronal multiplanar reconstruction computed tomography image demonstrating a congenital malformation of the left temporal bone. Note the absence of the left zygomatic arch and the hypoplasia of the left mandibular condyle.

Acute Traumatic Intracranial Hemorrhage (Figure 9.4)

Figure 9.4 Acute traumatic intracranial hemorrhage
Axial computed tomography image demonstrating a large acute subdural hemorrhage. Note the midline shift to the right and the effacement of the left lateral ventricle.

Figure 3.3.2 Retained cementum may still be attached to the gingival tissue or may be exposed by the gingival tissue. Cementum that is exposed can be removed with hand instruments or ultrasonic scalers to prevent the gingival tissue from healing.

Figure 3.3.3 This mandibular right first molar is attached to the lateral periodontal ligament by the fibrous periodontal attachment.

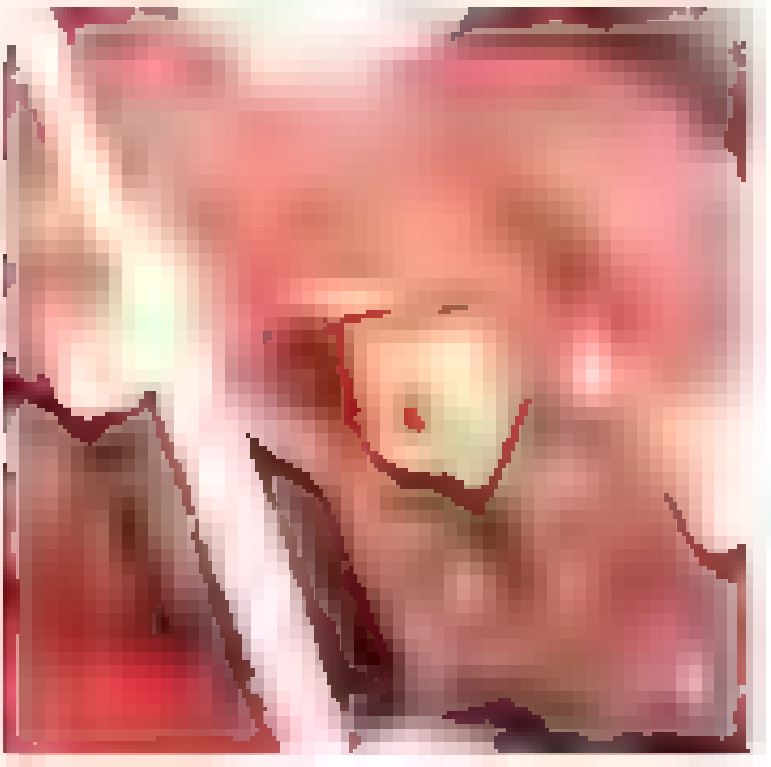


Figure 3.6 Wire-bent palatal bar. Note right-angle bends toward the teeth but terminating short of the gingival margin. Acrylic is required to complete the appliance.

Patient with male factor requiring orthodontic treatment (Figure 3.7)

Figure 3.7 The patient had mandibular malocclusion with the canine teeth lingual to the palatal mucosa. Orthodontic treatment is kept on hold during removal of the animal from breeding program. It is essential to prevent recurrence of the skeletal malocclusion post-

Figure 13.8 This is a caption that was manufactured to fill paragraph figure text.

Paragraph explaining what surgeon, including cumulative discussion (Figure 13.8).

Figure 13.9 Patients with the disease may also undergo surgery, sometimes together with surgeons in depressing and sad surgery.

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